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BULLETIN

DE LA

SOCIÉTÉ FOUAD I^{er} D'ENTOMOLOGIE

anciennement :

Société Entomologique d'Egypte (1907-1922)
et *Société Royale Entomologique d'Egypte* (1923-1937)



32
FONDÉE LE 1^{er} AOUT 1907

PLACÉE SOUS LE HAUT PATRONAGE DU GOUVERNEMENT EGYPTIEN
PAR DÉCRET ROYAL EN DATE DU 15 MAI 1923

LE CAIRE
IMPRIMERIE PAUL BARBEY

1948

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BULLETIN
DE LA
SOCIÉTÉ FOUAD I^{er} D'ENTOMOLOGIE

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Société Entomologique d'Egypte (1907-1922)
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FONDÉE LE 1^{er} AOÛT 1907

PLACÉE SOUS LE HAUT PATRONAGE DU GOUVERNEMENT EGYPTIEN
PAR DÉCRET ROYAL EN DATE DU 15 MAI 1923

LE CAIRE
IMPRIMERIE PAUL BARBEY

—
1948

Les opinions émises dans les publications de la Société sont propres à leurs auteurs. La Société n'en assume aucunement la responsabilité.

Date de parution et de distribution du présent Volume :

31 Décembre 1948

Le Rédacteur en Chef :

A. ALFIERI

**DÉCRET DONNANT LE NOM DE
FOUAD PREMIER
A DES INSTITUTIONS PUBLIQUES CRÉÉES SOUS SES AUSPICES ⁽¹⁾**

Nous, FAROUK 1er, Roi d'Egypte,

Sur la proposition du Président de Notre Conseil des Ministres tendant à perpétuer le souvenir de feu le Roi Fouad Premier et à glorifier Son nom, vu que Son règne s'est distingué par des œuvres éminentes dans le domaine des réformes et par la création de maintes institutions publiques dont la réalisation s'est accomplie grâce à Ses conseils et à Sa sollicitude, ce qui a eu la plus grande influence sur l'orientation et le développement de la renaissance scientifique, littéraire, sociale et économique de l'Egypte;

Sur l'avis conforme de Notre Conseil des Ministres;

DECRETONS

Art. 1 — Le nom de Fouad Premier est donné aux institutions et établissements indiqués au tableau annexé au présent décret. ⁽²⁾

Art. 2. — Le Président de Notre Conseil des Ministres est chargé de l'exécution du présent décret, qui entrera en vigueur dès sa publication au « Journal Officiel ».

Fait au Palais de Montazah, le 11 Gamad Tani 1357 (7 Août 1938).

FAROUK

Par le Roi :

Le président du Conseil des Ministres p.i.

ABDEL-FATTAH YEHIA

(Traduction)

(1) Extrait du *Journal Officiel* du Gouvernement Egyptien, N° 94, du Jeudi 11 Août 1938.

(2) Parmi ces institutions et établissements, figure, sub 7 : *Société Fouad 1^{er} d'Entomologie au lieu de Société Royale Entomologique d'Egypte.*

**DÉCRET NOMMANT LE PRÉSIDENT
DE LA SOCIÉTÉ FOUAD I^{er} D'ENTOMOLOGIE ⁽¹⁾**

Nous, FAROUK I^{er}, Roi d'Egypte,

Vu le Décret du 15 Mai 1923 approuvant les Statuts de la Société Fouad I^{er} d'Entomologie.

Sur la proposition du Président de Notre Conseil des Ministres et l'avis conforme du dit Conseil;

DÉCRETONS

Art. 1. — S.E. Mahmoud Hifnaoui Pacha, Conseiller Technique du Ministère de l'Agriculture, est nommé Président de la Société Fouad I^{er} d'Entomologie.

Art. 2. — Le Président de Notre Conseil des Ministres est chargé de l'exécution du présent décret.

Fait au Palais d'Abdine, le 6 Moharram 1359 (14 Février 1940).

FAROUK

Par le Roi :

Le Président du Conseil des Ministres,
ALY MAHER

(Traduction)

⁽¹⁾ Extrait du *Journal Officiel* du Gouvernement Egyptien, 67^{ème} année, N° 18, du Lundi 19 Février 1940.

**HAUTS PROTECTEURS
DE LA SOCIÉTÉ FOUAD I^{er} D'ENTOMOLOGIE**

Le Très Regretté Roi FOUAD I^{ER}

et

Sa Majesté le Roi FAROUK I^{ER}

MEMBRES BIENFAITEURS

1924

M. MOUSTAPHA MOURAD EL-SALANEKLI Bey, de Damanhour (Béhéra).

1925

S.E. EL-SAYED FATHALLAH MAHMOUD Pacha, de Rahmania (Béhéra);
M. RIAD ABDEL-KAWI EL-GEBALI Bey, de Chebin-El-Kom (Menoufia); S.E.
GEORGES WISSA Pacha, d'Assiout (Haute-Egypte); M. YEHIA KAWALLI Bey,
de Minieh (Haute-Egypte); M. YACOB BIBAWI ATTIA Bey, de Minieh
(Haute-Egypte); S.E. HASSAN CHARAWI Pacha, de Minieh (Haute-Egypte);
S.E. HABIB CHENOUDA Pacha, d'Assiout (Haute-Egypte); M. MOHAMED
TEWFIK MOHANNA Bey, de Tewfikieh (Béhéra); M. HASSAN AHMED MOUSSA
Bey, de Minieh (Haute-Egypte); M. LABIB BARSOUM HANNA Bey, de Minieh
(Haute-Egypte); S.E. HASSAN MOHAMED EL-TAHTAWI Pacha, de Ghirgheh
(Haute-Egypte); M. KASSEM OSMAN EL-LABBAN Bey, de Ghirgheh (Haute-
Egypte); M. DORDEIR EL-SAYED AHMED EL-ANSARI Bey, de Ghirgheh
(Haute-Egypte); M. BARSOUM SAID ABDEL-MESSIH Bey, de Minieh (Haute-
Egypte); M. DORDEIR TAHA ABOU-GOUNEMA Bey, de Minieh (Haute-Egypte).

1926

M. MOHAMED RIFAAT EL-ROZNAMGY Bey.

1927

M. le Dr. WALTER INNES Bey (décédé en 1937); M. le Dr. Avocat
GIOVANNI FERRANTE (décédé en 1946).

1928

M. le Professeur HASSAN C. EFFLATOUN Bey, du Caire; M. HUGO
LINDEMAN (décédé en 1937).

1932

M. ALFRED REINHART (décédé en 1935).

ORGANISATION ADMINISTRATIVE POUR L'ANNEE 1948

Membres du Conseil

S.E. le Prof. MAHMOUD TEWFIK HIFNAOUI Pacha, *Président*.

M. le Prof. HASSAN C. EFFLATOUN Bey, *Vice-Président*.

M. MOHAMED SOLIMAN EL-ZOHEIRY Bey, *Vice-Président*.

M. ANASTASE ALFIERI, *Secrétaire-Général*.

M. RICHARD WILKINSON, *Trésorier*.

M. le Prof. Dr. HAMED SELEEM SOLIMAN Bey.

M. le Prof. Dr. KAMEL MANSOUR.

M. le Dr. ASSAAD DAOUD HANNA.

M. ABDEL-MEGUID EL-MISTIKAWY.

M. EDGARD CHAKOUR.

M. le Dr. MOHAMED SHAFIK Bey.

M. le Dr. SAADALLAH MOHAMED MADWAR.

Comité Scientifique

M. le Prof. HASSAN C. EFFLATOUN Bey, M. le Prof. Dr. HAMED SELEEM SOLIMAN Bey, M. MOHAMED SOLIMAN EL-ZOHEIRY Bey, M. le Dr. ASSAAD DAOUD HANNA, M. le Prof. Dr. KAMEL MANSOUR, M. ABDEL-MEGUID EL-MISTIKAWY, M. le Dr. SAADALLAH MOHAMED MADWAR, M. ANASTASE ALFIERI.

Censeurs

M. E. KAOURK et M. ELHAMY GREISS.

LISTE DES MEMBRES

DE LA

SOCIÉTÉ FOUAD I^{er} D'ENTOMOLOGIE

EN 1948

(Les noms des Membres Fondateurs sont précédés de la lettre F)

Membres Honoraires

- 1908 ALLUAUD (Charles), Les Ouches à Crozant (Creuse), France.
- 1924 EBNER (Prof. Richard), 3, Beethovengasse, Vienne (X), Autriche.
- 1929 PEYERIMHOFF DE FONTENELLE (P. de), 87, Boulevard Saint-Saëns
Alger, Algérie.
- 1908 PIC (Maurice), Les Guerreaux, par Saint-Agnan (Saône-et-Loire),
France.
- 1940 SILVESTRI (Prof. F.), Ecole Supérieure d'Agriculture, Portici
(Naples), Italie.
- 1943 UVAROV (Dr. B.P.), British Museum (Natural History), Londres,
S.W. 7, Angleterre.
- F WILLCOCKS (F.C.), « Brambles », Hurst Lane, Sadlescombe (near
Battle), Sussex, Angleterre.

Membres Correspondants

- 1932 ALFKEN (J.D.), 18, Delmestrasse, Brême, Allemagne.
- 1926 HALL (Dr. W.J.), c/o The Imperial Institute of Entomology, 41,
Queen's Gate, London, S.W.7, Angleterre.
- 1924 HINDLE (Prof. Dr. Edouard), Zoological Society of London,
Regent's Park, London, N.W. 8, Angleterre.
- 1923 HUSTACHE (A.), Pensionnat Saint-Laurent, Lagny (Seine-et-Mar-
ne), France.
- 1925 KIRKPATRICK (Thomas Winfrid), The Imperial College of Tropi-
cal Agriculture, Trinidad, British West Indies.
- 1934 KOCH (C.), (13 b), Gelting (Post Plienig), Obb. Bayern, Ame-
rikanische Zone, Allemagne.
- 1929 MASI (L.), Museo Civico di Storia Naturale « Giacomo Doria »,
9, Via Brigata Liguria, Genova (102), Italie.

- 1934 SCHATZMAYR (A.), Museo Civico di Storia Naturale, 55, Corso Venezia, Milano, Italie.
- 1927 WILLIAMS (C.B.), Rothamsted Experimental Station, Harpenden, Herts, Angleterre.

Membres Titulaires

- 1913 ABAZA Pacha (S.E. Fouad), Directeur Général de la Société Royale d'Agriculture, Boîte Postale N° 63, au Caire.
- 1908 ALFIERI (Anastase), Secrétaire Général et Conservateur de la Société Fouad I^{er} d'Entomologie, Boîte Postale N° 430, au Caire.
- 1941 AMIN EL-DIB (Abdel-Latif), Faculté d'Agriculture, Université Farouk I^{er}, Camp de César, Alexandrie.
- 1938 ATTIA (Rizk), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1945 AZAB (Dr. Ahmed Kamel), Département d'Entomologie, Faculté d'Agriculture, Université Fouad I^{er}, Sharia El-Madares, Ghizeh, près le Caire.
- 1938 BAILEY BROS AND SWINFEN LTD., 11, Ronalds Road, Highbury, London, N. 5, Angleterre.
- 1948 BAROLOCCI (Dr. Mario), 30, Sharia Fouad I^{er}, au Caire.
- 1929 BICHARA (Ibrahim), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1946 BIGIO (Henri), Embassy Court, 11, Sharia Gabalaya, Ghézireh, au Caire.
- 1923 BODENHEIMER (Prof. F.S.), Hebrew University, Jerusalem, Palestine.
- 1938 CARNERI (Alexandre), 9, Sharia Ebn El-Farred, Attarine, Alexandrie.
- 1929 CASSAB (Antoine), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1923 CENTRAL LIBRARY, Research Division, Agriculture and Forests, Wad Medani, Soudan.
- 1943 CHAARAWI (Ahmed Mounir), Assistant Technique, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- F CHAKOUR (Edgard), Secrétaire Général de la Société Anonyme des Eaux du Caire, Boîte Postale N° 55, au Caire.
- 1931 COMPAGNIE UNIVERSELLE DU CANAL MARITIME DE SUEZ (Monsieur l'Agent Supérieur de la), 20, Sharia Dar El-Chefa, Kasr El-Doubara, Boîte Postale N° 2120, au Caire.

- 1944 COYNE (Dr. F.P.), c/o Imperial Chemical Industries Ltd. (General Chemistry Division), Pest Control Section, Randle, Astmoor, Runcom, Cheshire, Angleterre.
- 1934 CRÉDIT FONCIER EGYPTIEN (Monsieur l'Administrateur-Délégué), 35, Sharia El-Malika Farida, au Caire.
- 1944 DAIRA DRANEHT Pacha, Sarawella, par Kafr-Dawar (Béhéra), Basse-Egypte.
- 1948 DAUD (Hanna), Section d'Entomologie, Ministère de l'Agriculture, Dokki, (Ghizeh), près le Caire.
- 1938 DIRECTORATE-GENERAL OF AGRICULTURE, Ministry of Economics, Baghdad, Irak.
- 1928 DOLFFUS (Robert Ph.), Directeur de Laboratoire et de Recherches, Museum National d'Histoire Naturelle, 57, Rue Cuvier, Paris (V^{me}), France.
- 1919 EFFLATOUN Bey (Prof. Hassan C.), Vice-Doyen et Professeur d'Entomologie, Faculté des Sciences, Université Fouad I^{er}, 16, Sharia El-Cheikh Hamza, au Caire.
- 1946 EL-KHISHEN (Dr. Shafik Aly), Faculté d'Agriculture, Université Farouk I^{er}, Camp de César, Alexandrie.
- 1948 ELZIADY (Mademoiselle Samira), Département d'Entomologie, Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.
- 1947 EZZ (Ahmed Ibrahim), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1947 EZZAT (Yehia Mahmoud), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Guizeh), près le Caire.
- 1944 FACULTÉ D'AGRICULTURE (Bibliothèque de la), Université Farouk I^{er}, Camp de César, Alexandrie.
- 1934 FACULTÉ D'AGRICULTURE, Université Fouad I^{er}, Sharia El-Madares, Ghizeh, près le Caire.
- 1946 FACULTÉ DE MÉDECINE (Bibliothèque de la), Université Farouk I^{er}, Alexandrie.
- 1941 FAHMY (Aly), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1948 FRANGOPOULOS (Aristide Mikhali), Ingénieur Agronome, Borg Gianacis, Abou Matamir (Béhéra), Basse-Egypte.
- 1914 GARBOUA (Maurice), 1, Midan Soliman Pacha, au Caire.
- 1938 GHABN (Dr. Abdel-Aziz), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1927 GHALI Pacha (S.E. Wacef Boutros), c/o S.E. Saba Habachi Pacha, 41, Sharia El-Malika Farida, au Caire.

- 1938 GHESQUIÈRE (J.), 87, Avenue du Castel, Bruxelles (W. St L.), Belgique.
- 1947 GHIBRIAL (Mounir), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1945 GREEN (J.) & Co., Département Agriculture, 147, Sharia Mohamed Bey Farid (ex Emad El-Dine), Boîte Postale N° 600, au Caire.
- 1921 GREISS (Elhamy), 215, Sharia El-Malika Nazli, au Caire.
- 1942 HABIB (Abdallah), Professeur d'Entomologie à l'Institut Supérieur d'Agriculture, Chebin El-Kom (Menoufieh), Basse-Egypte.
- 1936 HAFEZ (Dr. Mahmoud), Professeur-Adjoint d'Entomologie, Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.
- 1944 HAFEZ (Moustafa), Laboratoire des Insectes Parasites, Cotton Research Board, Ghizeh (Orman), près le Caire.
- 1948 HAIRIS (Dr. R. Wheeler), c/o Monsieur le Docteur Ibrahim Shawki Bey, Doyen de la Faculté de Médecine, Université Fouad I^{er}, Sharia Kasr El-Aïni, au Caire.
- 1938 HAMZA (Soliman), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1938 HANNA (Dr. Assaad Daoud), Gezira Research Farm, Wad Medani, Soudan.
- 1944 HASSAN (Dr. Abbas Ibrahim), Département de Zoologie, Faculté des Sciences, Université Fouad I^{er} (Ghizeh, Orman), 80, Sharia Saleh El-Din, Héliopolis, près le Caire.
- 1945 HASSAN (Dr. Ahmed Abdel-Gawad), Section d'Entomologie, Faculté d'Agriculture, Université Farouk I^{er}, Camp de César, Alexandrie.
- 1928 HASSAN (Dr. Ahmed Salem), Professeur de Zoologie et d'Entomologie à la Faculté d'Agriculture, Université Fouad I^{er}, Sharia El-Madares, Ghizeh, près le Caire.
- 1944 HASSAN (Mahrus Saleh), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1940 HIFNAOUI Pacha (S.E. le Prof. Mahmoud Tewfik), Conseiller Technique du Ministère de l'Agriculture et Président de la Société Fouad I^{er} d'Entomologie, Sharia Lazogly, Héliouan, près le Caire.
- 1927 HOUSNY (Mahmoud), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1943 HUSSEIN (Mohamed), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1938 IBRAHIM (Abdel-Hamid Ibrahim), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

- 1940 IBRAHIM (Ahmed Housny), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1948 IBRAHIM (Mohamed Mahmoud), Laboratoire des Insectes Parasites, Cotton Research Board, Ghizeh (Orman), près le Caire.
- 1944 IMPERIAL CHEMICAL INDUSTRIES (EGYPT), S.A., 15, Midan Mohamed Aly, P.O. Bag, Alexandrie.
- 1936 IMPERIAL CHEMICAL INDUSTRIES (EGYPT), S.A., 26, Sharia Chérif Pacha, P.O. Bag, au Caire.
- 1928 IZZET Bey (Mohamed), 14, Midan El-Daher, au Caire.
- 1927 KAMAL (Dr. Mohamed), Professeur d'Entomologie à la Faculté des Sciences, Université Farouk I^{er}, 7, Sharia Saïd Pacha, Giannacis, Ramleh, Alexandrie.
- 1922 KAOURK (Elias A.), Avocat, c/o Egyptian Markets Company Ltd, 14, Sharia Emad El-Dine, au Caire.
- 1926 KASSEM (Mohamed), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1943 KEFL (Ahmed Hassanein El-), Démonstrateur au Département d'Entomologie, Faculté d'Agriculture, Université Fouad I^{er}, Sharia El-Madares, Ghizeh, près le Caire.
- 1938 KLEIN (Dr. H.Z.), Agricultural Research Station, Boîte Postale N° 15, Rehovoth, Palestine.
- 1923 LABORATOIRES D'HYGIÈNE PUBLIQUE (Bibliothèque), Sharia El-Sultan Hussein, au Caire.
- 1931 LAND BANK OF EGYPT (Monsieur l'Administrateur-Directeur), Boîte Postale N° 614, Alexandrie.
- 1944 LEAN (Owen Bevan), Old Forge Cottage, Winkfield, Windsor, Angleterre.
- 1931 LYCÉES FRANÇAIS (Monsieur le Proviseur), 2-4, Sharia Youssef El-Guindi, au Caire.
- 1948 MACRI (Dr. Giuseppe), 12, Sharia Nouzha, Héliopolis, près le Caire.
- 1922 MADWAR (Dr. Saadallah Mohamed), Directeur de la Section d'Eradication des Insectes, Ministère de l'Hygiène Publique, Sharia El-Falaki, au Caire.
- 1948 MAHER (Abdel Meneim), Démonstrateur à la Faculté d'Agriculture, Université Fouad I^{er}, Sharia El-Madares, Ghizeh, près le Caire.
- 1927 MANSOUR (Prof. Dr. Kamel), D. Sc., Département de Zoologie, Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.
- 1947 MEYMARIAN (Albert T.), Directorate of Agriculture, Baghdad, Iraq.

- 1943 MILAD (Dr. Anis Boutros), Entomologiste attaché à la Section de Pathologie Animale (Département Vétérinaire du Ministère de l'Agriculture), 1, Sharia Yacoub, El-Dawawine, au Caire.
- 1921 MISTIKAWY (Abdel Megid El-), Société Royale d'Agriculture, Boîte Postale N° 63, au Caire.
- 1945 MOAZZO (Polychronis Georges), 2, Sharia Young, Alexandrie.
- 1944 MORCOS (Georges), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1929 MOSSERI (Dr. Henri), 25, Sharia Talaat Harb Pacha, au Caire.
- 1947 MOUGEL (Henri), Professeur de Sciences Naturelles au Lycée Franco-Egyptien, Héliopolis, près le Caire.
- 1944 MOURSI (Dr. Abdel-Fattah Aly), Laboratoire des Insectes Parasites, Cotton Research Board, Ghizeh (Orman), près le Caire.
- 1947 NAHAS (Adnan), Ingénieur Agronome, Rue Maurice Barrès, Beyrouth, Liban.
- 1943 NAKHLA (Naguib), Assistant Technique, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1942 OKBI (Mahmoud Ismail El-), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1944 PALMONI (J.), Beth Gordon, Daganian A, P.O. Kinneret, Palestine.
- 1939 PANTOS (Jean G.), Ingénieur Agronome, Boîte Postale N° 1074, Elisabethville, Congo Belge.
- 1944 PLANTA & C° (J.), Boîte Postale N° 450, Alexandrie.
- 1928 PRIESNER (Prof. Dr. H.), Expert Entomologiste, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1947 RAMY (Farid), Ingénieur Agronome, Immeuble Makarem, Rue des Arts et Métiers, Beyrouth, Liban.
- 1942 RAWHY (Soheil Hussein), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1932 RIVNAY (E.), P.O.Box 91, Rehovoth, Palestine.
- 1943 RIZKALLAH (Ramses), Assistant Technique, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1925 ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (The), 41, Queen's Gate, South Kensington, Londres, S.W. 7, Angleterre.
- 1948 SABET FRÈRES & Co. (Les Filis de D. Sabet), 9, Sharia Emad El-Dine, Boîte Postale N° 966, au Caire.
- 1947 SAGAN (Jean), Zoologiste, c/o J. Domanski, Banknock House, Banknock (Stirlingshire), Ecosse, Angleterre.

- 1943 SAMAE (Mohamed Mohamed), Assistant Technique, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1941 SAWAF (Saleh Kamel El-), Faculté d'Agriculture, Université Farouk I^{er}, Camp de César, Alexandrie.
- 1936 SAYED (Dr. Mohamed Taher El-), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1938 SHAFIK Bey (Dr. Mohamed), Directeur Technique de la Société Financière et Industrielle d'Egypte, Boîte Postale N° 7, Kafr-Zayat, Basse-Egypte.
- 1948 SHALABY (Fathy Mohamed), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1924 SHAW (Fred), Northgate, Sherborne, Dorset, Angleterre.
- 1938 SOCIÉTÉ DU NAPHTHE, S.A. (A.I. Mantacheff & Co.), 33, Sharia Chérif Pacha, Boîte Postale N° 313, au Caire.
- 1921 SOCIÉTÉ ROYALE D'AGRICULTURE, Laboratoire d'Entomologie de la Section Technique, Boîte Postale N° 63, au Caire.
- 1934 SOLIMAN Bey (Prof. Dr. Hamed Seleem), Doyen de la Faculté d'Agriculture, Université Fouad I^{er}, Sharia El-Madares, Ghizeh, près le Caire.
- 1928 SOLIMAN (Dr. Labib Boutros), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.
- 1948 STRAWSON CHEMICAL Co. (The), Boîte Postale N° 268, au Caire.
- 1946 TAHER (Mahmoud), c/o J. de Planta & Co., 1, Sharia Baehler, Kasr El-Nil, Boîte Postale N° 424, au Caire.
- 1926 TEWFIK (Mohamed), Chef de Laboratoire et Conservateur des collections entomologiques de la Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.
- 1935 TRACTOR AND ENGINEERING COMPANY, S.A.E. (The), 18, Sharia Emad El-Dine, Boîte Postale N° 366, au Caire.
- 1945 TRIANTAPHYLIDIS (Nicolas P.), Assistant technique, Bureau de l'Attaché Agricole, Embassade d'Amérique, Athènes, Grèce.
- 1926 WALY (Dr. Mohamed), Conférencier en Zoologie, Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.
- 1947 WATERSTON (A.R.), Entomologiste Conseil du B.M.E.O., 10, Sharia Tolumbat, Garden City, au Caire.
- 1912 WILKINSON (Richard), Immeuble Baehler, 157, Sharia Fouad I^{er}, Zamalek, au Caire (Ouest).
- 1947 WILTSHIRE (E.P.), Premier Secrétaire d'Embassade et Consul de S.M. Britannique, 19, Sharia Gameh Charkas, au Caire.

- 1946 ZAAZOU (Dr. Hussein), Faculté d'Agriculture, Université Farouk I^{er}, Camp de César, Alexandrie.
- 1948 ZAKI (Mademoiselle Malaka), Département d'Entomologie, Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.
- 1943 ZAKI (Mikhaïl), Section d'Entomologie, Musée Agricole Fouad I^{er}, Dokki (Ghizeh), près le Caire.
- 1944 ZERVUDACHI (Emmanuel), Boîte Postale N° 1277, Alexandrie.
- 1938 ZOHEIRY Bey (Mohamed Soliman El-), Directeur-Général de la Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

Envois divers

Bibliothèque du Cabinet de SA MAJESTÉ LE ROI, Palais d'Abdine, au Caire.

Bibliothèque privée de SA MAJESTÉ LE ROI (Monsieur le Conservateur de la), Palais de Koubbeh, près le Caire.

Son Excellence le Grand Chambellan de Sa Majesté le Roi, Palais d'Abdine, au Caire.

Son Excellence le Président du Conseil des Ministres, au Caire.

Son Excellence le Ministre de l'Agriculture, Dokki (Ghizeh), près le Caire.

Son Excellence le Président de la Cour des Comptes, au Caire.

Son Excellence le Président du Conseil d'Administration de la Société Royale d'Agriculture, Boîte Postale N° 63, au Caire.

Monsieur l'Administrateur-Délégué du Crédit Foncier Egyptien, 35, Sharia El-Malika Farida, au Caire.

Son Excellence le Président du Conseil d'Administration de la Banque Misr, 151, Sharia Emad El-Dine, au Caire.

Monsieur le Directeur Général de l'Imperial Chemical Industries (Egypt), 26, Sharia Chérif Pacha, au Caire.

Monsieur le Directeur Général de la Société Financière et Industrielle d'Egypte, 2, Sharia Fouad I^{er}, Alexandrie.

Son Excellence le Sous-Secrétaire d'Etat, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

Son Excellence le Secrétaire-Général du Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

Bibliothèque Centrale de l'Université Farouk I^{er}, Palais Prince Omar Toussoun, Sharia Lumbroso, Moharrem Bey, Alexandrie.

Centre de Coopération Scientifique (Unesco), Moyen-Orient, 33, Sharia El-Qasr El-Ali, au Caire.

Son Excellence l'Administrateur Général de la Khassa Royale, Palais d'Abdine, au Caire.

Son Excellence le Directeur du Cabinet Européen de Sa Majesté le Roi, Palais d'Abdine, au Caire.

Bibliothèque du Ministère de l'Instruction Publique, Sharia El-Falaki, au Caire.

Bibliothèque Egyptienne, Midan Bab El-Khalq, au Caire.

Bibliothèque du Musée Agricole Fouad I^{er}, Dokki (Ghizeh), près le Caire.

Nature, Macmillan and Co. Ltd., St. Martin's Street, London, W.C. 2, Angleterre.

Echanges

Afrique Occidentale Française

Institut Français d'Afrique Noire, Boîte Postale N° 206, Dakar.

Afrique du Sud

South African Museum, P.O. Box 61, Cape Town.

Department of Agriculture of the Union of South Africa (The Agricultural Journal of the Union of South Africa), Pretoria.

Department of Agriculture of the Union of South Africa, Division of Entomology, P.O. Box 513, Pretoria.

The Director, The Transvaal Museum, P.O. Box 413, Pretoria.

The Honorary Secretary, Entomological Society of Southern Africa, P.O. Box 103, Pretoria.

Algérie

Société d'Histoire Naturelle de l'Afrique du Nord, c/o Monsieur L. Faurel, Laboratoire de Botanique, Faculté des Sciences d'Alger, Alger.

Office National Anti-Acridien, Institut Agricole d'Algérie, Maison-Carée, Alger.

Allemagne

Deutsche Entomologische Gesellschaft, 43, Invalidenstrasse, Berlin (IV).
Senckenbergischen Bibliothek, Senckenberg-Anlage 27, Frankfurt A/M.
Bücherei des Zoologischen Museums, 43, Invalidenstrasse, Berlin N 4.
Gesellschaft für Vorratsschutz E.V. (Mitteilungen der), 31, Zimmermannstrasse, Berlin-Steglitz.

Bücherei der Biologischen Anstalt für Land- und Forstwirtschaft, 19, Königin-Luise-Str., Berlin-Dahlem.

Deutsches Entomologisches Institut der Kaiser Wilhelm Gesellschaft (Arbeiten über morphologische und taxonomische Entomologie, Arbeiten über physiologische und angewandte Entomologie), 20, Gossler Strasse, Berlin-Dahlem.

Deutsche Kolonial und Uebersee-Museum, Bahnhofplatz, Brême.

Naturhistorischer Verein der Rheinlande und Westfalens (Entomologische Blätter, Decheniana), 41, Bennauerstrasse, Bonn (22c).

Münchener Entomologischen Gesellschaft E.V. (Mitteilungen der), Menzingerstrasse 13, Zone Américaine, Munich 38.

Angleterre

The Commonwealth Institute of Entomology, Publication Office and Library (Review of Applied Entomology), 41, Queen's Gate, London, S.W. 7.

Zoological Museum (Novitates Zoologicae), Tring Park, Tring, Herts.

The Apis Club (The Bee World), The Way's End, Foxton, Royston, Herts.

Cambridge Philosophical Society, New Museums, Free School Lane, Cambridge.

The Director, Anti-Locust Research Centre, British Museum (Natural History), London, S.W. 7.

The Librarian, The Zoological Society of London, Regent's Park, London, N.W. 8.

The Librarian, Department of Entomology, University Museum, Oxford.

Argentine

Instituto Biologico de la Sociedad Rural Argentina, Buenos Aires.

Sociedad Cientifica Argentina, 11.45, Calle Santa Fé, Buenos Aires.

Sociedad Entomologica Argentina, 267, Calle Maipu, Buenos Aires.

Museo Argentino de Ciencias Naturales « Bernadino Rivadavia », Casilla de Correo N° 10, Suc. 5, Buenos Aires.

Ministerio de Agricultura (Boletin del Ministerio de Agricultura de la Nacion), Bibliotheca, 974, Paseo Colon, Buenos Aires.

Instituto Miguel Lillo, Universidad Nacional de Tucuman, Calle Miguel Lillo N° 205, Tucuman.

Asociacion Argentina de Artropodologia, Lacar 3722, Buenos Aires.

Australie

The Australian Museum (The Librarian), Sydney, N.S.W.

Council for Scientific and Industrial Research, 314, Albert Street, East Melbourne, C.2.

The Entomologist's Office, Department of Agriculture, Sydney, N.S.W.

The Public Library, Museum, and Art Gallery of South Australia,
Box 386 A, G.P.O., Adelaide, South Australia.

The Library of the Division of Economic Entomology, P.O. Box N° 109,
Canberra City, F.C.T.

The Linnean Society of New South Wales, Science House, Gloucester
and Essex Streets, Sydney, N.S.W.

Autriche

Administration-Kanzlei des Naturhistorischen Museums, Burgring 7,
Vienne (I).

Zoologisch-Botanische Gesellschaft, 2, Mechelgasse, Vienne (III).

Koleopterologische Rundschau, c/o Zoologisch-Botanische Gesellschaft.
2, Mechelgasse, Vienne (III).

Belgique

Société Entomologique de Belgique, Musée Royal d'Histoire Naturelle
de Belgique, 31, Rue Vautier, Bruxelles, 4.

Société Scientifique de Bruxelles, Secrétariat, 11, Rue des Récollets,
Louvain.

Bulletin de l'Institut Agronomique et des Stations de Recherches de
Gembloux, Bibliothèque de l'Institut Agronomique de l'Etat, Gembloux.

Lambillionnea, Revue Mensuelle Belge d'Entomologie, c/o M. Lucien
Berger, 2, Vallée des Artistes, Linkebeek, Bruxelles.

Annales du Musée du Congo Belge, Tervuren.

Association des Ingénieurs sortis de l'Institut Agronomique de l'Etat, à
Gembloux, 35, Avenue des Volontaires, Anderghem-Bruxelles.

Brésil

Museu Nacional, Quinta da Boa Vista, Rio de Janeiro.

Instituto Biologico, Bibliotheca, Caixa 119-A, São Paulo.

Instituto Oswaldo Cruz, Caixa de Correio 926, Rio de Janeiro.

Arquivos do Serviço Florestal, 1008, Jardim Botânico, Rio de Janeiro.

Academia Brasileira de Ciencias (Anais da Academia Brasileira de
Ciencias), Caixa Postal 229, Rio de Janeiro.

Divisao de Intercambio e Documentacao, Fundação Getúlio Vargas,
Praia de Botafogo, 186-92, Caixa Postal 4081, Rio de Janeiro.

Bulgarie

Institutions Royales d'Histoire Naturelle, Musée Royal d'Histoire Natu-
relle, Palais Royal, Sofia.

Société Entomologique de Bulgarie, Musée Royal d'Histoire Naturelle, Palais Royal, Sofia.

Société Bulgare des Sciences Naturelles, Musée Royal d'Histoire Naturelle, Palais Royal, Sofia.

Canada

Entomological Division, Science Service, Department of Agriculture, Ottawa, Ontario.

Bibliothèque du Ministère Fédéral de l'Agriculture, Edifice de la Confédération, Ottawa.

Entomological Society of Ontario (The Canadian Entomologist, and Reports), Guelph, Ontario.

Nova Scotian Institute of Science, Halifax.

Chine

The Lingnan Science Journal, Lingnan University, Canton.

Bulletin of the Biological Department, Science College, National Sun Yat-Sen University, Canton.

Bureau of Entomology of the Chekiang Province, West Lake, Hangchow.

Chypre

The Cyprus Agricultural Journal (The Office of the Gouvernement Entomologist), Nicosia.

Colombie (République de), Amérique du Sud

Facultad Nacional de Agronomia (Biblioteca de la), Medellin.

Cuba

Sociedad Cubana de Historia Natural « Felipe Poey » (Memorias) c/o Dr. Carlos Guillermo Agnayo, 25 N° 254, Vedado, La Havane.

Danemark

Entomologisk Fcrening, Zoologisk Museum, Krystalgade, Copenhagen.

Egypte

Ministère de l'Agriculture, Bibliothèque de la Section d'Entomologie, Dokki (Ghizeh), près le Caire.

Société Royale d'Agriculture, Bibliothèque de la Section Technique, Boîte Postale N° 63, au Caire.

Union des Agriculteurs d'Egypte, 25, Sharia Talaat Harb Pacha, au Caire.

The Bee Kingdom, 60, Sharia Menascé, Alexandrie.

Bibliothèque du Musée Agricole Fouad I^{er}, Dokki (Ghizeh), près le Caire.

Académie Egyptienne des Sciences (Monsieur le Secrétaire Honoraire de l'), Dar El-Hikma, 42, Sharia Kasr El-Afni, au Caire.

Feuilles Agricoles, c/o Lycée Français, Chatby, Alexandrie.

Al-Fellaha, Boîte Postale N° 2047, au Caire.

Société Royale de Géographie d'Egypte, Bureau Postal de Kasr El-Doubara, au Caire.

The Journal of the Royal Egyptian Medical Association, Kasr El-Aini Post Office, au Caire.

Société Fouad I^{er} d'Economie Politique, de Statistique et de Législation, Boîte Postale N° 732, au Caire.

Institut d'Egypte, 13, Sharia El-Sultan Hussein, au Caire.

Bibliothèque de la Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.

Equateur (République de l'), Amérique du Sud

Director General de Agricultura (Revista del Departamento de Agricultura), Quito.

Boletín de la Sección Agrícola del Banco Hipotecario del Ecuador, Apartado 685, Quito.

Espagne

Instituto Nacional de 2^a Ensenanza de Valencia, Laboratorio de Hidrobiología Espanola, Valencia.

Junta para ampliacion de Estudios e Investigaciones Científicas, 4, Duque de Medinaceli, Madrid.

Eos, Revista Espanola de Entomologia, Instituto Espanol de Entomologia, Hipodromo, Madrid (VI).

Real Academia de Ciencias y Artes, 9, Rambla de los Estudios, Barcelona (II).

Real Sociedad Espanola de Historia Natural (Biblioteca), Palacio de Bellas Artes, 84, Avenida del Generalísimo, Madrid.

Estacion Central de Fitopatologia Agrícola, 17, Miguel Angel, Madrid (6).

Instituto de Ciencias Naturales, Museo Municipal de Ciencias Naturales, Apartado de Correos 593, Barcelone.

Etats-Unis

The Research Library, Buffalo Society of Natural Sciences, Buffalo Museum of Science, Humboldt Park, Buffalo, New-York.

University of Illinois Library, Exchange Division, Urbana, Illinois.

The Library, American Museum of Natural History, Central Park West at 79th Street, New-York City.

The Ohio State University (The Ohio Journal of Science), Columbus 10, Ohio.

California Academy of Science Library (Pan-Pacific Entomologist), Golden Gate Park, San Francisco, 18, California.

Academy of Natural Sciences, Entomological Section, Lagon Square, Philadelphia.

Experiment Station of the Hawaiian Sugar Planters' Association, P.O. Box 411, Honolulu, T.H., Hawaii.

Hawaiian Entomological Society (The Secretary), 1527, Keeaumoku Street, Honolulu 4, Hawaii.

Carnegie Museum, Department of the Carnegie Institute, Pittsburgh, Pennsylvania.

American Entomological Society (The), 1900, Race Street, Philadelphia. 3, Penna.

United States Department of Agriculture (The Library), Washington 25, D.C.

General Library, University of Michigan, Ann Arbor, Michigan.

United States National Museum, c/o Smithsonian Institution, Washington, D.C.

Smithsonian Institution Library, Washington, D.C.

New-York State College of Agriculture (The Library), Cornell University, Ithaca, New-York.

New-York Academy of Sciences, New-York.

University of California (The Library), College of Agriculture, Agricultural Experiment Station, Berkeley 4, California.

University of California, Citrus Experimental Station Library, Riverside, California.

Wisconsin Academy of Sciences, Arts, and Letters, 120, Wisconsin State Historical Building, Madison, Wisconsin.

The Library, Minnesota Agricultural Experiment Station, University Farm, Saint Paul, Minnesota.

Museum of Comparative Zoology, Harvard College, Cambridge, Mass.

The Philippine Agriculturist (The Library of the College of Agriculture). Agricultural College, Laguna, Philippine Islands.

The Wasmann Collector (The Managing Director), Department of Biology, University of San Francisco, San Francisco 17, California.

The Reading Public Museum and Art Gallery (The Librarian), Reading, PA.

Editorial Office, The American Midland Naturalist, University of Notre Dame, Notre Dame, Indiana.

Marine Biological Laboratory (The Library), Woods Hole, Mass.

The Library, State College of Washington, Agricultural Experiment Station, Pullman, Washington.

Finlande

Societas Entomologica Helsingforsiensis (Notulae Entomologicae), Museum Zoologicum, Helsingfors.

Societas pro Fauna et Flora Fennica, Kaserngatan 24, Helsinki.

Societas Zoologica-Botanica Fennica Vanamo, Säätytalo, Snellmaninkatu 9-11, Helsinki.

Société Entomologique de Finlande (Annales Entomologici Fennici), Institut de Zoologie Agricole et Forestière de l'Université, Snellmaninkatu 5, Helsinki.

France

L'Echange (Revue Linnéenne), Les Guerreaux, par Saint-Agnan (Saône et Loire).

Revue française d'Entomologie, Museum National d'Histoire Naturelle (Entomologie), 45 bis, Rue de Buffon, Paris (V°).

Revue Scientifique du Bourbonnais et du Centre de la France, 22, Avenue Meunier, Moulins (Allier).

Société d'Etudes des Sciences Naturelles de Nîmes, 6, Quai de la Fontaine, Nîmes (Gard).

Société de Pathologie Végétale et d'Entomologie Agricole de France, Institut Pasteur, 25, Rue du Docteur Roux, Paris (XV°).

Société Linnéenne de Bordeaux, Athénée, 53, Rue Des Trois Conils, Bordeaux.

Société Linnéenne de Lyon, 33, Rue Bossuet, Lyon (VI°)

Société des Sciences Naturelles de l'Ouest de la France, Nantes (Loire Inférieure).

Association des Naturalistes de Levallois-Perret, 153, Rue du Président Wilson (Domaine de la Planchette), Levallois-Perret (Seine).

Société Linnéenne du Nord de la France, 81, Rue Lemerchier (M. Pauchet), Amiens.

Société Géologique de Normandie et des Amis du Museum du Havre, Hôtel des Sociétés Savantes, 56, Rue Anatole France, Le Havre (Seine Inférieure).

Société d'Histoire Naturelle de Toulouse (Monsieur P. Bonnet, Bibliothécaire de la), Faculté des Sciences, Toulouse.

Société Entomologique de France, Institut National Agronomique, 16, Rue Claude Bernard, Paris (V°).

Société d'Etudes Scientifiques de l'Aude, Carcassone (Aude).

Annales des Epiphyties et de Phytogénétique, Centre National des Recherches agronomiques, à Versailles.

Museum National d'Histoire Naturelle, Bibliothèque, 8, Rue de Buffon, Paris (V°).

Société de Zoologie Agricole (Revue de Zoologie Agricole et Appliquée), Faculté des Sciences, Institut de Zoologie, 40, Rue Lamartine, Talence (Gironde).

L'Entomologiste (Monsieur le Rédacteur en Chef de), Muséum National d'Histoire Naturelle, Entomologie, 45 bis, Rue de Buffon, Paris (V°).

Rédaction du Bulletin Analytique, Service de Documentation du Centre National de la Recherche Scientifique, Ministère de l'Education Nationale, 45, Rue d'Ulm, Paris (V°).

Institut des Fruits et Agrumes Coloniaux, 7, Rue Saint-Dominique, Paris (VII°).

Grèce

Institut Phytopathologique Benaki, Kiphissia (près Athènes).

Bibliothèque de l'Institut et Musée Zoologique de l'Université, Athènes.

Hollande

Nederlandsche Entomologische Vereeniging (Bibliotheek van der). Zeeburgerdijk. 21, Amsterdam (O).

Landbouwhoogeschool, Laboratorium voor Entomologie, Berg 37, Wageningen.

Hongrie

Természettudományi Múzeum, 13, Baross-utca, Budapest.

Indes Anglaises

Zoological Survey of India (Records of the Indian Museum), Kaiser Castle, Benares Cautt.

Madras Government Museum, Connemara Public Library, Egmore, Madras.

Office of the Director, Imperial Agricultural Research Institute, New Delhi.

Indes Néerlandaises

Bibliotheca Bogoriensis, Grooteweg 20, Buitenzorg, Java.

Iran

Laboratoires du Département Général de la Protection des Plantes (Monsieur le Directeur), Ministère de l'Agriculture, Tehran.

Italie

Museo Civico di Storia Naturale « Giacomo Doria », 9, Via Brigata Liguria, Genova (102).

Rivista di Biologia Coloniale, 326, Viale Regina Margherita (Policlinico), Roma.

Museo Civico di Storia Naturale di Trieste (Atti del), 4, Piazza Hortis, Trieste (10).

Società dei Naturalisti in Napoli, Università di Napoli, Via Mezzo-cannone, Napoli.

Società Entomologica Italiana, Museo Civico di Storia Naturale, 9, Via Brigata Liguria, Genova (102).

Società Adriatica di Scienze Naturali, 7, Via dell'Annunziata, Trieste.

La Stazione di Entomologia Agraria (Redia), 15-17, Via Romana, Firenze.

La Stazione Sperimentale di Gelsicoltura e Bachicoltura di Ascoli Piceno.

Istituto Zoologico dell'Università di Napoli (Biblioteca del), Via Mezzo-cannone, Napoli.

Laboratorio di Zoologia Generale e Agraria della Facoltà Agraria, Portici (Napoli).

Laboratorio di Entomologia Agraria di Portici (Bolletino del), Portici (Napoli).

Institut International d'Agriculture (Bibliothèque de l'), Villa Umberto I, Rome.

Società italiana di Scienze Naturali, Palazzo del Museo Civico di Storia Naturale, Corso Venezia, Milano.

Istituto di Zoologia dell'Università di Genova (Bolletino dei Musei di Zoologia e di Anatomia comparata), 5, Via Balbi, Genova.

Società dei Naturalisti e Matematici di Modena, presso l'Università, Modena.

Istituto di Entomologia dell'Università, 6, Via Filippo Re, Bologna (125).

Accademia di Scienze, Lettere ed Arti in Padova, 15, Via Accademia, Padova (Veneto).

Museo di Storia Naturale della Venezia Tridentina (« Memorie del Museo di Storia Naturale della Venezia Tridentina » e « Studi Trentini di Scienze Naturali »), Casella Postale 95, Trento.

Istituto Agronomico per l'Africa (Rivista di Agricoltura subtropicale e tropicale), Ministero dell'Africa, 13, Via Fibonacci, Firenze.

Università degli Studi (Bolletino di Zoologia Agraria e Bachicoltura), 2, Via Celoria, Milano (133).

Società Veneziana di Storia Naturale (presso Sig. Antonio Giordani Soika), S. Marco 254, Venezia.

Japon

Saghalien Central Experiment Station, Konuma, Saghalien.

The Chara Institute for Agricultural Research, Library, Kurashiki, Okayama-Ken.

Imperial Agricultural Experiment Station (Journal of the), Nishigahara, Tokyo.

Department of Agriculture, Government Research Institute, Taihoku, Formosa.

The Kansai Entomological Society, c/o N. Tosawa, Shibakawa-Noen, Kotoen, Mukogun, Hyogo-ken.

« Mushii », Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka.

Takeuchi Entomological Laboratory (Tenthredo, Acta Entomologica), Shinomyia Yamashina, Kyoto.

Kenya Colony (British East Africa)

East Africa Natural History Society (The Hon. Secretary), Coryndon Memorial Museum, P.O. Box 658, Nairobi.

Libye

Museo Libico di Storia Naturale, Piazza Santa Maria degli Angeli Tripoli d'Africa.

Maroc

Société des Sciences Naturelles du Maroc, Institut Scientifique Chérifien, Avenue Biarnay, Rabat.

Service de la Défense des Végétaux (Monsieur le Chef du), 65 bis, Avenue de Témara, Rabat.

Mexique

Junta Nacional Directora de la Campana contra la Langosta (Junosta), Biblioteca, Departamento Directivo, Veracruz.

Biblioteca del Instituto Biotecnico, Calzada Mexico-Tacuba N° 295, Col. Anahuac, D.F.

Biblioteca del Instituto de Biología, Chapultepec (Casa del Lago), Mexico, D.F.

Anales de la Escuela Nacional de Ciencias Biológicas, Apartado Postal 7016, Mexico, D.F.

Norvège

Tromso Museum Library, Tromso.

Panama (République de)

Departamento Seccional de Agricultura (Boletin Agricola), Panama.

Pologne

Musée Zoologique Polonais, ul. Wilcza N° 64, Varsovie.

Société Polonaise d'Entomologie (Bulletin Entomologique de la Pologne), ul. Sienkiewicza 21, Instytut Zoologiczny Uniwersytetu we Wrocławiu, Wrocław.

Institut Polonais des Recherches Forestières (Instytut Badawczy Lesnictwa, Biblioteka), Al. Mickiewicza 25, Cracovie.

Uniwersytet Marii Curie-Skłodowskiej, Biuro Wydawnictu, 5, Plac Litewski, Lublin.

Porto-Rico

Institute of Tropical Agriculture, P.O. Box 1195, Mayaguez.

Portugal

Société Portugaise des Sciences Naturelles, Faculté des Sciences, Rue de l'Ecole Polytechnique, Lisbonne.

Museum Zoologique de l'Université de Coimbra, Largo Marquês de Pombal, Coimbra.

Associação da Filosofia Natural (Bibliotecario da), Faculdade de Ciencias, Porto.

Instituto de Medicina Tropical (Monsieur le Directeur de l'), Lisbonne.

Roumanie

Société Transylvanienne des Sciences Naturelles (Siebenbürgischer Verein für Naturwissenschaften), Hermannstadt, Sibiu.

Academia Romana, Bibliothèque, Calea Victoriei, 125, Bucarest.

Russie (U.R.S.S.)

Société Entomologique de Russie (Revue d'Entomologie de l'U.R.S.S.), Musée Zoologique de l'Académie des Sciences, Leningrad.

Bibliothèque de l'Académie des Sciences de l'Ukraine, 58a, Rue Korolenko, Kiew (Ukraine).

Société des Naturalistes de Kiew, 37-10, Rue Korolenko, Kiew (Ukraine).

Institut des Sciences Naturelles, Université M. Gorky, 1 ul. Genkelya, Zaimka, Molotov (Oural).

The Lenin Academy of Agricultural Sciences, Institute for Plant Protection, 42, Herzen str., Leningrad.

Rédaction du Journal « Plant Protection », 7, Rue Tschaikovsky, Léningrad.

Institute for controlling Pests and Diseases, Library, 7, Rue Tschaikovsky, Léningrad 28.

Siam

Department of Agriculture and Fisheries, Entomology Section, Bangkok.

Suède

K. Swenska Vetenskapsakademien i Stockholm (Bibliotek), Stockholm 50.

Entomologiska Föreningen (Bibliothèque de l'), Stockholm, 50.

Göteborgs Kungl. Vetenskaps-och Vitterhets Samhälles, Göteborg.

Statens Växtskyddsanstalt, Stockholm 19.

Bibliothèque de l'Université de Lund, Lund.

Suisse

Bibliothèque de la Société Entomologique Suisse, Musée d'Histoire Naturelle, Berne.

Tausch-Stelle der Naturforschenden Gesellschaft, Zentralbibliothek, Zähringerplatz 6, Zurich I.

Tchécoslovaquie

Societas Entomologica (Casopis), u Karlova 3, Prague II.

« Sbornik » (Acta Entomologica), Section de Zoologie du Musée National, Prague, II-1700.

Bibliothèque de la Société Zoologique Tchécoslovaque, Institut de Zoologie, Karlov 3, Prague II.

Uruguay (République de l')

Escuela de Veterinaria del Uruguay (Anales de la Escuela de Veterinaria del Uruguay), Itazaingo 1461, Montévideo.

Sociedad de Biología de Montevideo, Casilla de Correo 567, Montevideo.

Yougoslavie

Societas Entomologica Jugoslavica (Glasnik), 17, Garasaninovo ulica, Belgrade.

Abonnement de la Société

Bulletin of Entomological Research, The Commonwealth Institute of Entomology, 41, Queen's Gate, S.W. 7, Londres, Angleterre.

PROCÈS-VERBAUX DES REUNIONS

Réunion du Conseil du 25 Février 1948

Présidence de Monsieur ABDEL MEGUID EL-MISTIKAWY.

Congrès :

Est approuvée l'adhésion de la Société au VI^e CONGRÈS INTERNATIONAL DES MALADIES TROPICALES ET DE LA MALARIA (Washington, 10-18 Mai 1948), au XIII^e CONGRÈS INTERNATIONAL DE ZOOLOGIE (Paris, 21-27 Juillet 1948), et au VIII^e CONGRÈS INTERNATIONAL D'ENTOMOLOGIE (Stockholm, 9-14 Août 1948). Nos délégués à ces manifestations scientifiques seront désignés ultérieurement.

Admission d'un Membre :

Sur la proposition de Messieurs MOHAMED SOLIMAN EL-ZOHEIRY Bey et ABDEL HAMID IBRAHIM, la STRAWSON CHEMICAL C^o, de Londres, est admise à faire partie de la Société en qualité de Membre Titulaire.

Don à la Bibliothèque :

Monsieur le Docteur J. BALAZUC, de Paris, a fait parvenir un exemplaire de son travail « La tératologie des coléoptères et expériences de transplantation sur *Tenebrio molitor* L. », publié dans les Mémoires du Museum National d'Histoire Naturelle, nouvelle série, tome XXV (fascicule unique), 1947 [1948], Paris.

Le Conseil remercie.

Echange de Publications :

Le Conseil approuve l'échange avec les Institutions ci-après :

L'UNIVERSITÉ MARIE CURIE-SKŁODOWSKIEJ, Lublin (Pologne).

THE WASMANN COLLECTOR, organe du Département de Biologie de l'Université de San-Francisco, Californie (Etats-Unis).

LES LABORATOIRES DU DÉPARTEMENT GÉNÉRAL DE LA PROTECTION DES PLANTES, Ministère de l'Agriculture, Téhéran (Iran).

Rapports Annuels :

Les Rapports du Secrétaire Général, du Trésorier et des Censeurs pour l'Assemblée Générale Ordinaire sont soumis au Conseil qui les approuve. La date de cette Assemblée est fixée au 31 Mars 1948.

Assemblée Générale Ordinaire du 31 Mars 1948

Présidence

de Monsieur le Professeur H. C. EFFLATOUN Bey, *Vice-Président*.

Rapport du Secrétaire Général (Exercice 1947) :

Messieurs,

Aux termes des Articles 24, 25 et 26 de nos Statuts, nous vous avons convoqués en Assemblée Générale Ordinaire pour vous présenter les Rapports du Secrétaire Général, du Trésorier et des Censeurs sur la situation morale, financière et comptable de la Société, pour donner au Conseil décharge de sa gestion, et pour procéder, par voie d'élections, au remplacement des Membres sortants du Conseil, et des deux Censeurs des comptes de l'Exercice en cours.

Messieurs,

Le 31 Juillet 1947 la Société Fouad I^{er} d'Entomologie a accompli sa quarantième année d'existence.

Si nous nous enorgueillissons en face du passé et du présent de notre chère Société, n'oublions pas ceux qui l'ont fondée, absents ou présents, et ceux qui l'ont aidée moralement ou matériellement. Rendons-leur le juste hommage qu'ils ont mérité, et qu'ils trouvent ici l'expression de toute notre gratitude.

A cette occasion, nous avons sollicité et obtenu la bienveillante autorisation de Sa Majesté le Roi Farouk I^{er}, de dédier à l'auguste mémoire de Son très regretté Père, le Roi Fouad I^{er}, premier patron de la Société, le volume du quarantième anniversaire de notre fondation.

Dans ce bulletin de quatre-cents pages et abondamment illustré, sont consignés dix-sept travaux entomologiques qui témoignent de l'activité de nos membres. On y trouvera, entre autres, les descriptions de deux lépidoptères nouveaux du Sinaï, *Coenobasis Farouki* et *Anydrophila Fouadi*, publiées avec la permission royale. Une belle planche en photo-chromo graveure accompagne ces descriptions.

La note dominante de l'Exercice est la forte recrudescence des visiteurs. Notre musée, et particulièrement nos salles de lecture, ont été quotidiennement fréquentés par les professeurs et les étudiants des Facultés des Sciences et d'Agriculture des Universités Fouad I^{er} et Farouk I^{er}, ainsi que par les techniciens du Ministère de l'Agriculture. Nous leur avons fourni de très

nombreuses références bibliographiques indispensables à leurs travaux, et une infinité de déterminations d'insectes.

Nous avons reçu du Ministère de l'Agriculture 830 livres égyptiennes à titre de subvention, contre 1000 l'année précédente.

Les donations qui nous sont parvenues sont celles de la Société Royale d'Agriculture, du Crédit Foncier Egyptien, de l'Imperial Chemical Industries, de la Banque Misr, et de la Société Financière et Industrielle d'Egypte, respectivement de livres égyptiennes 50, 50, 25, 20 et 15. A tous ceux qui ont recommandé ou approuvé l'octroi de ces donations, nous renouvelons nos remerciements et l'expression de notre gratitude, et nous les prions de vouloir bien continuer à nous témoigner leur bienveillant appui.

Des démarches sont en cours en vue de la réduction de l'impôt foncier qui vient d'être augmenté de livres égyptiennes vingt et six-cents millièmes.

Le nombre de nos membres et adhérents de toutes catégories s'élève à 370.

Il existe actuellement dans notre bibliothèque 16059 ouvrages et brochures, dûment enregistrés, contre 15495 l'année précédente, soit en augmentation de 564 unités. Dix-sept d'entre-eux représentent les dons reçus, vingt-trois ont été acquis, le restant provient de nos échanges avec 213 institutions entomologiques ou scientifiques de quarante-six pays.

Nous avons été chargés par la Section d'Entomologie du Ministère de l'Agriculture de compléter la formation entomologique d'un de ses techniciens. Nous l'avons guidé de notre mieux toute l'année durant, et nous sommes heureux d'annoncer qu'il a fait des progrès sérieux dans l'entomologie systématique.

C'est à Stockholm que se tiendra cette année, du 9 au 14 Août, le VIII^e Congrès International d'Entomologie. La Société y a adhéré. Cependant, il est peu probable qu'elle puisse y être représentée par un délégué officiel.

Nous estimons utile de vous exposer, aussi brièvement que possible, notre situation financière.

Durant les dix années qui ont précédé la guerre, la moyenne de nos dépenses était de 1500 livres égyptiennes, que nos recettes couvraient. Les choses ont bien changé depuis. Le coût de la vie continue à être extrêmement élevé. Cette année, nous avons dépensé 2073 livres égyptiennes, ce qui constitue un minimum raisonnable pour l'administration courante de la Société dans les conditions présentes. Par contre, nos recettes n'ont été que de 1773 livres égyptiennes. Il a donc fallu combler le déficit par un prélèvement de 300 livres égyptiennes sur la réserve générale. D'autre part, nous devons penser aussi à la conservation de notre Siège social. A part les quelques petites réfections urgentes entreprises chaque année, voici

bientôt quinze ans que nous différons l'exécution des grosses réparations. Autre chose aussi. Avec ses 16000 ouvrages traitant presque exclusivement de l'entomologie, vous vous rendez compte de la valeur scientifique et des possibilités de travail que notre bibliothèque offre aux zoologues et particulièrement aux entomologistes. Il faut la développer, la compléter par des acquisitions nouvelles. Nous devons protéger ce patrimoine par la reliure du plus grand nombre possible d'ouvrages. Mais les fonds manquent, et c'est là le majeur souci de votre Conseil d'Administration et particulièrement de votre Trésorier.

Votre Trésorier a établi le Bilan des Comptes du quarantième Exercice Social, dûment vérifié et approuvé par vos Censeurs, ainsi que les Prévisions budgétaires pour l'Exercice 1948. L'excédent des dépenses sur les recettes sera de 233 livres égyptiennes qu'il faudra encore prélever sur la réserve générale.

Aux termes de l'Article 13 de nos Statuts, le Conseil est annuellement renouvelé par tiers. Les membres sortants cette année sont les suivants : Messieurs le Professeur Hamed Selim Soliman Bey, Mohamed Soliman El-Zoheiry Bey, et le Docteur Mohamed Shafik Bey. Ils sont rééligibles.

Vos Censeurs, Messieurs E.A. Kaourk et Elhamy Greiss sont également rééligibles.

En terminant, nos pensées sont respectueusement dédiées à notre auguste et bien-aimé Souverain, Sa Majesté le Roi Farouk I^{er}, et nous Lui exprimons nos sentiments de profond dévouement et nos vœux les plus fervents.

Signé : A. AIFERI.

Rapport du Trésorier :

Situation au 31 Décembre 1947

DÉPENSES

RECETTES

	L.E.	MM.		L.E.	MM.
Impôts et Assurances	84	416	Subvention Ministère Agriculture	830	995
Frais Généraux et Entretien...	197	024	Donations.....	160	000
Personnel	1023	300	Cotisations des Membres.....	97	805
Publications	684	400	Droits d'Inscriptions.....	2	000
Bibliothèque	84	549	Intérêts de Banque	19	217
			Coupons Emprunt National....	583	520
			Vente Publications	67	575
			Encaissements divers.....	12	000
			Déficit prélevé sur la Réserve Générale	300	577
	2073	689		2073	689

ACTIF

PASSIF

	L.E.	MM.		L.E.	MM.
Immeuble Social	1	000	Réserve Générale	15604	924
Mobilier	1	000			
Bibliothèque	1	000			
Collections	1	000			
Laboratoires	1	000			
Banque Nationale d'Egypte	2407	665			
Portefeuille Emprunt National.	13187	630			
Compagnie du Gaz.....	4	629			
	15604	924		15604	924

Portefeuille Titres en dépôt à la Banque Nationale d'Egypte : 18000
L.Eg. Emprunt National 3 1/4 % (1963-1973).

Signé : R. WILKINSON.

Rapport des Censeurs :

En exécution du mandat que vous avez bien voulu nous confier, nous avons l'honneur de porter à votre connaissance que nous avons vérifié les Comptes de la Société Fouad I^{er} d'Entomologie pour l'année finissant le 31 Décembre 1947, avec les registres et documents y relatifs.

Nous certifions que le Bilan reflète d'une façon exacte et sincère la situation de la Société telle qu'elle ressort des registres et des explications qui nous ont été données.

Signé : E. A. KAOURK et ELHAMY GREISS.

Prévisions Budgétaires pour l'année 1948 :

RECETTES			DÉPENSES		
	L. E.	MM.		L. E.	MM.
Subvention Ministère Agriculture .	1000	000	Loyer	2	000
Donations	160	000	Impôts	57	000
Cotisations des Membres	100	000	Assurances	27	000
Coupons Emprunt National	583	000	Frais Généraux	250	000
Intérêts de Banque	19	000	Entretien	50	000
Vente Publications	5	000	Personnel	1050	000
Prélèvement sur la Réserve Générale	233	000	Publications	500	000
			Bibliothèque	80	000
			Imprévus	84	000
	2100	000		2100	000

Signé : R. WILKINSON.

Décisions :

1) Le Procès-Verbal de l'Assemblée Générale Ordinaire du 26 Mars 1947 est lu et confirmé.

2) Les Rapports du Secrétaire Général, du Trésorier et des Censeurs pour l'Exercice 1947, ainsi que les Prévisions Budgétaires pour l'Exercice 1948, sont lus et approuvés.

3) L'Assemblée donne décharge au Conseil de sa gestion pour l'Exercice 1947.

Elections :

Messieurs le Professeur Docteur HAMED SELEEM SOLIMAN Bey, MOHAMED SOLIMAN EL-ZOHEIRY Bey, et le Docteur MOHAMED SHAFIK Bey, membres du Conseil sortants, sont réélus pour trois ans.

Messieurs E. A. KAOURK et ELHAMY GREISS sont réélus Censeurs des Comptes de la Société pour l'Exercice 1948.

Félicitations et Remerciements :

Avant de se séparer et sur la proposition du Président, l'Assemblée Générale Ordinaire félicite les Membres du Conseil et les Censeurs réélus, et vote une motion de remerciements à l'adresse de Messieurs le Secrétaire Général, le Trésorier, les Membres du Conseil, les Censeurs, et de toutes les personnes ou institutions qui, par leurs dons, leurs contributions scientifiques et leur sympathie constante, ont aidé la Société à remplir sa tâche durant l'exercice écoulé.

Réunion du Conseil du 5 Mai 1948

Présidence de Monsieur le Professeur H. C. EFFLATOUN Bey,
Vice-Président.

Donations :

La Société a reçu L.Eg. 100 de la SOCIÉTÉ DU NAPhte, S.A. (A. I. MANTACHEFF & Co) et L.Eg. 50 du CRÉDIT FONCIER EGYPTIEN.

Le Conseil remercie.

Admission de Membres :

Sont admis à faire partie de la Société en qualité de Membres Titulaires : Mademoiselles MALAKA ZAKI et SAMIRA ELZIADY, du Département d'Entomologie de la Faculté des Sciences (Université Fouad I^{er}), présentées par Messieurs le Professeur H. C. EFFLATOUN Bey et ANASTASE ALFIERI ; Monsieur HANNA DAOUD, présenté par Messieurs ANTOINE CASSAB et ANASTASE ALFIERI ; Messieurs les Docteurs GIUSEPPE MACRI et MARIO BARTOLOCCI, du Caire, proposés par Messieurs R. WILKINSON et ANASTASE ALFIERI ; Messieurs SABET FRÈRES & Co. (Les Fils de D. Sabet), du Caire, présentés par Messieurs MOHAMED SOLIMAN EL-ZOHEIRY Bey et ABDEL MEGUID EL-MIS-TIKAWY.

Dons à la Bibliothèque :

Monsieur le Professeur F. SILVESTRI, de Portici (Naples) fait don de 9 tirés à part de ses récents travaux.

Monsieur E. P. WILTSHIRE nous a remis diverses brochures de ses publications sur les Lépidoptères du Moyen-Orient.

Le Conseil remercie.

Bureau du Conseil pour l'Exercice 1948 :

Sont réélus : Messieurs le Professeur H. C. EFFLATOUN Bey et MOHAMED SOLIMAN EL-ZOHEIRY Bey, *Vice-Présidents* ; Monsieur ANASTASE ALFIERI, *Secrétaire-Général* ; Monsieur RICHARD WILKINSON, *Trésorier*.

Comité Scientifique :

Sont réélus : Messieurs le Professeur H. C. EFFLATOUN Bey, MOHAMED SOLIMAN EL-ZOHEIRY Bey, le Professeur Docteur KAMEL MANSOUR, le Docteur SAADALLAH MOHAMED MADWAR, le Docteur ASSAAD DAOD HANNA, ABDEL MEGUID EL-MISTIKAWY, et ANASTASE ALFIERI.

**Commémoration du Douzième Anniversaire
de la mort du Roi Fouad I^{er}
(28 Avril 1948)**

Comme chaque année, les membres du Conseil d'Administration de la Société se sont rendus à la mosquée d'El-Rifaï pour déposer une couronne sur la tombe royale et rendre hommage à la mémoire du Grand Souverain disparu. Après avoir salué Sa Majesté le Roi Farouk I^{er}, ils furent s'inscrire sur les registres du Palais d'Abdine.

**Anniversaire de l'Avènement au Trône
de Sa Majesté le Roi Farouk I^{er}
(6 Mai 1948)**

A l'occasion de l'Avènement au Trône de Sa Majesté le Roi Farouk I^{er}, les Membres du Conseil de la Société ont adressé une dépêche de félicitations à Son Excellence le Grand Chambellan, et se sont inscrits sur les registres royaux du Palais d'Abdine.

Réunion du Conseil du 6 Octobre 1948

Présidence de Monsieur le Dr. MOHAMED SHAFIK Bey.

Nécrologie :

Le Secrétaire Général a le regret de faire connaître le décès de Monsieur le Commandeur Professeur Ingénieur ARTURO S. GAROZZO, membre de la Société depuis 1907.

Délégués aux Congrès Internationaux :

La Société a délégué Monsieur le Docteur SAADALLAH MOHAMED MADWAR au VI^e CONGRÈS INTERNATIONAL DES MALADIES TROPICALES ET DE LA MALARIA, Monsieur le Professeur KAMEL MANSOUR au XIII^e CONGRÈS INTERNATIONAL DE ZOOLOGIE, et Monsieur MOHAMED SOLIMAN EL-ZOHEIRY Bey au VIII^e CONGRÈS INTERNATIONAL D'ENTOMOLOGIE.

Admission de Membres :

Sont admis à faire partie de la Société en qualité de Membres Titulaires : Monsieur MOHAMED MAHMOUD IBRAHIM, du Laboratoire des Insectes Parasites (Ministère de l'Agriculture), présenté par Messieurs le Docteur ABDEL-FATTAH ALY MOURSI et A. ALFIERI; Monsieur ARISTIDE MIKHALI FRANGOPOULOS, Ingénieur Agronome, présenté par Messieurs MAHMOUD TAHER et A. ALFIERI.

Donations :

La Société a reçu les donations ci-après : L.Eg. 25 de l'IMPERIAL CHEMICAL INDUSTRIES, L.Eg. 20 de la BANQUE MISR, et L.Eg. 15 de la SOCIÉTÉ FINANCIÈRE ET INDUSTRIELLE D'EGYPTE.

Le Conseil remercie.

Echange de Publications :

Le Conseil approuve l'échange avec les Institutions ci-après : INSTITUTO DE MEDICINA TROPICAL (Anais do), Lisbonne (Portugal); l'ASOCIACION ARGENTINA DE ARTEROPODOLOGIA (Buenos Aires); et le Centre de Coopération Scientifique du Moyen Orient (UNESCO).

Réunion du Conseil du 8 Décembre 1948

Présidence de Monsieur le Professeur H. C. EFFLATOUN Bey,

Vice-Président.

Subvention :

Le Ministère de l'Agriculture nous a fait parvenir sa subvention annuelle de L.Eg. 1000.

Le Conseil remercie.

Don à la Bibliothèque :

Monsieur le Professeur J. OMER-COOPER, de Grahamston (Afrique du Sud), a fait parvenir un tiré à part de ses dix récents travaux sur l'entomologie.

Le Conseil remercie.

Admission d'un Membre :

Sur la proposition de Messieurs le Professeur Docteur HAMED SELEEM SOLIMAN Bey et ANASTASE ALFIERI, Monsieur ABDEL MONEIM MAHER, démonstrateur à la Faculté d'Agriculture (Université Fouad I^{er}), est admis à faire partie de la Société en qualité de Membre Titulaire.

CONTRIBUTIONS TO THE KNOWLEDGE
OF THE NATURAL ENEMIES OF MEALYBUGS

1.

Description of two new species of *Anagyrus*

[Hymenoptera : Encyrtidae]

(with 16 Text-Figures)

by A.A. MOURSI, B.Sc., M.S., Ph.D.,
Parasites Laboratory,
Entomological Section, Ministry of Agriculture, Cairo.

Anagyrus kamali nov. spec.

Female (fig. 1) : Head, frontal view, about one seventh wider than high; median facial prominence well developed; scrobes formed as shallow perpendicular grooves convergent above, about two times the length of antennal sockets; sockets separated from each other by their own length and from the oral margin one third their own length; upper margin of sockets tangent to the basal orbital line; head, dorsal view, fronto-vertex wider than long; posterior ocelli more or less at equal distance from the orbital and occipital margins.

Antennal scape widely expanded and exclusive of the radicle about twice as long as wide; pedicel two times as long as wide and about one and one fifth as long as the first funicle joint, the latter about twice as long as wide; funicle joints slightly increasing in width distad and very slightly decreasing in length so that the sixth is slightly shorter in length and about one and one fifth as wide as the first; club one and two fifths as wide as last distal funicle joint and slightly longer than the length of the pedicel and the first funicle joint combined.

Body moderately robust; the mesoscutellum one and one quarter as wide as long and about one and one third the length of the mesoscutum; abdomen four fifths the length of the head and thorax united; ovipositor slightly protruding beyond the tip of the abdomen.

Wings reaching well beyond the apex of the abdomen; forewings more than twice as long as broad; venation as seen in figure 7.

Apex of middle tibia with numerous peg-like spines; plantar surface of metatarsus with fourteen similar spines, second tarsal joint with eight spines, third with seven, and fourth with five spines; metatarsus of middle leg one and one sixth the length of its tibial spur and slightly less than twice the length of the second and third tarsal joints combined; metatarsus of the hind leg as long as the second and third tarsal joints combined; tibia of hind leg with a small conspicuous spur in addition to the strong spur.

Head, thorax and abdomen abundantly clothed with small refractive hairs which appear silvery or whitish due to light reflections; scutellum of prothorax with a row of small black bristles; posterior margin of mesoscutum with a pair of similar but longer bristles; scutellum with two pairs of long bristles near the apex and with a set of similar but shorter bristles on each side; tegula beset with number of black bristles; eyes with rather coarse but small erect black hairs; ocellar region beset with a number of small spines.

Colouration variable in degree and extent according to the season; in dark coloured specimens collected from the field in February, cheeks below the eyes whitish due to the presence of refractive hairs, background orange; face blackish, sides dark brown; eyes bluish green; radicle joint and scape of the antenna shining black except for a small narrow band at the apex and a very narrow band at the base of the latter; pedicel, except for the distal third or so which is whitish, blackish; first funicle joint brown; other funicle joints and club little darker than the distal end of first funicle joint; frontovertex rust red; concealed part of prothorax blackish; posterior part of prothorax orange suffused with brown; mesoscutum and mesoscutellum rust red; a blackish spot in the middle of scutellum; axillae brown; prepectus orange; tegulae white with brown tips; metathorax and abdomen blackish; coxae of middle and hind legs brown; trochanters, femora and tibiae whitish and at times suffused with brown; tarsi whitish flushed with orange; feet blackish; peg shaped spines on plantar surface of tarsi dark red; in light coloured specimens collected in August and September, sides of face of same colour as frontovertex; median blackish spot on mesoscutellum absent; axillae light brown; legs whitish, but tarsi flushed with light orange and feet blackish. — Length 1.5 mm..

Male (fig. 2) : Head, frontal view, slightly wider than long; antennal sockets high above the oral margin, their lower margin tangent to the basal orbital line; each socket slightly more than one and one quarter its own length from the oral margin; sockets convergent above and separated from each other by their own length; scrobes one and one fifth time the length

of the sockets and hardly convergent above; head, dorsal view, frontovertex wider than long; posterior ocelli greater than their own diameter from the orbits and much less than their own diameter from the occipital margin.

Scape exclusive of the radicle about twice and three fifths as long as broad; pedicel short, slightly longer than wide; first funicle joint cylindrical and largest joint, about four times as long as wide; other funicle joints subequal; club longer than the last two funicle joints combined; distal funicle joint carries on the ventral margin six short erect clavate hairs; ventral margin of club at base with two similar clavate hairs; venation of wings as shown in figure 8.

Colouration differs in degree and extent according to the season; in dark coloured specimens collected in February, face blackish, sides dark brown; cheeks under the orbits whitish due to the presence of refractive hairs, background orange; antennal radicle and scape shining black, except for a narrow band at the base and a broad band at the apex of the latter; pedicel, except for the lighter distal half, black; base of first funicle joint black; rest of funicle and most of club light in colour; distal end of club dark brown; base of each funicle joint dark brown; frontovertex blackish; area between posterior ocelli and orbits rust red suffused with brown; prothorax, mesoscutum, scutellum and abdomen blackish; sides of mesoscutum rust red clouded with brown; prepectus orange; tegulae white with brown tips; in light coloured specimens collected in September, sides of face rust red; area between posterior ocelli and orbits rust red. — Length 1 mm..

Described from 7 ♀♀ and seven ♂♂ bred from samples of the Hibiscus Mealybug (*Phenacoccus hirsutus* Green) collected around Cairo.

Holotype (♀) and Allotype (♂), Massara (January, 1946); Paratypes; Massara (January, 1946), Giza (June 1947), Tura (February 1948).

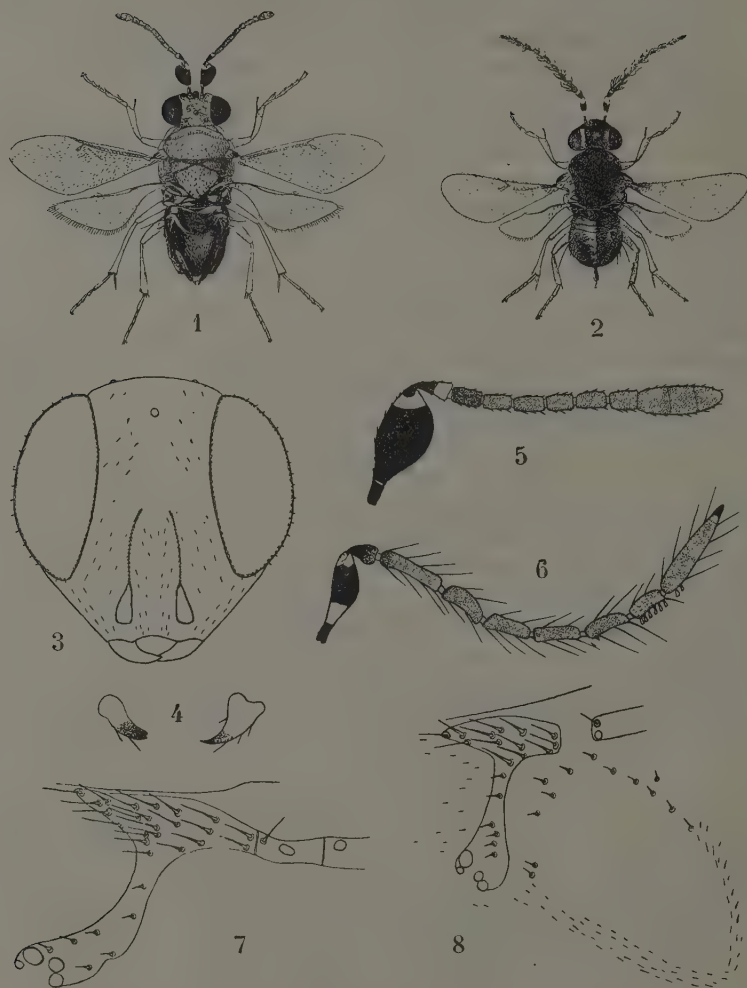
Deposited in the Museum of the Fouad Ist Entomological Society, Cairo.

This species is closely related to *Anagyrus subproximus* Silvestri, but is easily differentiated by the comparatively shorter postmarginal vein.

The author is indebted to Dr. Ch. Ferrière of the Natural History Museum of Genève (Switzerland), for valuable help and useful remarks.

***Anagyrus aegyptiacus* nov. spec.**

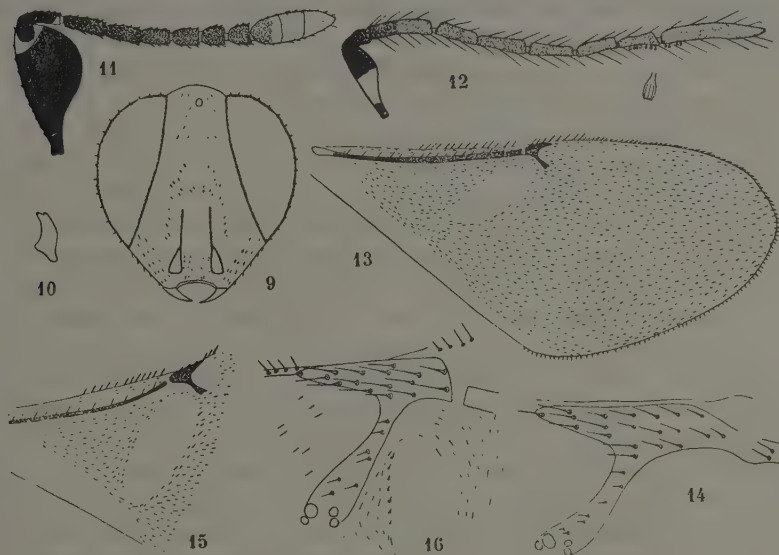
Female: Head, frontal view, one seventh wider than high; median facial prominence well developed as to be seen in profile; scrobes formed as shallow perpendicular grooves hardly convergent above, one time and half the length of antennal sockets; sockets separated from each other by a distance slightly longer than their own length and separated from the oral



Anagyrus kamali nov. spec.

Fig. 1 : Adult female, $\times 15$. — Fig. 2: Adult male, $\times 15$. — Fig. 3: Head, frontal view. — Fig. 4: Mandibles. — Fig. 5: Female antenna. — Fig. 6: Male antenna. — Fig. 7: Venation of female forewing. — Fig. 8: Venation of male forewing.

margin by one third the distance between them; upper margin of sockets tangent to the basal orbital line; head, dorsal view, frontovertex one and one fifth as long as wide, the posterior ocelli about half their own diameter from the orbit and slightly longer than their own diameter from the occipital margin.



Anagyrus aegyptiacus nov. spec.

Fig. 9: Head, frontal view. — Fig. 10: Mandible. — Fig. 11: Female antenna. — Fig. 12: Male antenna. — Fig. 13: Forewing of female. — Fig. 14: Venation of female forewing. — Fig. 15: Basal portion of forewing of male. — Fig. 16: Venation of male forewing.

Antennal scape widely expanded, and as long as the pedicel and the first two funicle joints combined; exclusive of the radicle about two times as long as wide; pedicel three times as long as broad and equal or very slightly shorter than the first funicle joint, the latter also about three times as long as broad; funicle joints slightly increasing in width distad, first joint the longest, following decreasing in length and slightly increasing in width so that the sixth three fifths the length of the first and one and one half time as wide; club about one and one half time the width of the last distal funicle joint and as long as the pedicel and the first funicle joint combined.

Body moderately robust; mesoscutellum about as long as wide and one and two fifths the length of mesoscutum; abdomen seven tenths the length of thorax and head united; ovipositor hardly protruding.

Wings reaching beyond the apex of the abdomen; forewing a little more than twice as long as wide; venation as seen in figure 14.

Apex of middle tibia with numerous peg-like spines; plantar surface of metatarsus with fourteen similar spines, second tarsal joint with eight, third with seven, and fourth with four spines; metatarsus of middle leg very slightly longer if not equal to the tibial spur and slightly shorter than the other tarsi combined; metatarsus of forelegs seven tenths the length of the following two tarsal segments; metatarsus of hind legs as long as the succeeding two tarsal segments combined.

Head, thorax and abdomen abundantly clothed with small refractive hairs which appear silvery or whitish due to light reflections; posterior margin of prothorax with a row of black very short bristles; posterior margin of mesoscutum beset with a pair of long black bristles; mesoscutellum with three pairs of long black bristles near its apex; eyes with rather coarse but small erect black hairs; small black hairs also scattered in ocellar region.

Colouration variable in degree and extent according to the season; dark coloured specimens collected in February, face and cheeks below the eyes blackish; frontovertex and sides of face rust red; region behind ocellar area suffused with brown; eyes bluish green; radicle joint and scape of antenna shining black except for a broad narrow band at the apex and a very narrow band at the base of the latter; pedicel except for a narrow part at the distal end black; first funicle joint blackish; second funicle joint very dark brown; other funicle joints and base of the club flushed with dusk; rest of club light; concealed part of prothorax blackish; posterior part of prothorax black but rendered silvery-white by the refractive white hairs which cover it; mesoscutum and mesoscutellum of the same colour as frontovertex; axillae of the same colour but flushed with dusk; upper corners of mesoscutum blackish; tegulae cream white but tips brown; a central dark brown spot might occur on mesoscutellum; prepectus of the same colouration as frontovertex; metanotum and abdomen blackish; in foreleg, coxa black, femur and tibia blackish, distal end of tibia slightly lighter in colour, tarsi flushed with dusk, foot blackish; middle leg, coxa black, femur and tibia suffused with dark brown, tarsi lighter in colour, foot blackish; hind leg, coxa black, femur, tibia and tarsi blackish, hind leg darker than other legs. — Length 1.8 mm.

Male: Head, frontal view, about one and one third as wide as long; antennal sockets high above the oral margin, their upper margin higher than the basal orbital line; each socket slightly less than its own length from orbital margin and four fifths this distance from one another; scrobes little longer than sockets and slightly convergent above; head, dorsal view, frontovertex one and three fifths as wide as long; posterior ocelli about their

own diameter from the orbits and much less their own diameter from occipital margin.

Scape excursive of radicle two and one half time as long as broad; pedicel short, a little longer than wide; first funicle joint cylindrical and longest joint almost about four times as long as wide, the rest of funicle joints are subequal; club a little longer than the last two distal funicle joints combined; distal funicle joint carrying on the ventral margin seven short erect clavate hairs; ventral margin of club at base with four similar clavate hairs; wing venation as in figure 16.

Head, thorax and abdomen black with white refractive hairs; eyes bluish green; ocelli deep red; radicle and scape except the basal half of the latter are shining black; the ventral surface of the basal half of the scape white, the distal half black but rendered white due to the presence of refractive white hairs; pedicel shining black in dark forms; first funicle joint very dark brown especially at the base; rest of funicle brown with the second funicle joint little darker than other joints; club also brown except the lighter distal part; base of each funicle joint and base of club dark brown; in light coloured forms only base of first funicle joint very dark brown; rest of funicle and club light in colour; prepectus reddish clouded with black; tegula whitish, tip brown; foreleg, coxa dark brown, femur black, tibia dark brown; middle leg, coxa dark brown, femur dark brown, tibia blackish; hind leg, coxa and femur dark brown, tibia blackish; tarsi in all the legs rust red clouded with black; feet black. — Length 1.0 mm.

Described from 14 ♀♀ and 2 ♂♂ bred from the Lebbek Mealybug (*Pseudococcus filamentosus* Ckll.) collected around Cairo.

Holotype (♀), Tura (February 1948); Allotype (♂), Giza (June, 1947); Paratypes, Giza (June, 1947) and Tura (February, 1948).

Deposited in the Museum of the Fouad Ist Entomological Society, Cairo

Closely related to *Anagyrus aurantifrons* Compere, but readily differentiated by its comparatively long postmarginal vein.

CONTRIBUTIONS TO THE KNOWLEDGE
OF THE NATURAL ENEMIES OF MEALYBUGS

2.

Anagyrus kamali Moursi,
a parasite of the Hibiscus Mealybug,
Phenacoccus hirsutus Green

[Hymenoptera : Encyrtidae]

(with 19 Text-Figures)

by A. A. MOURSI, B.Sc., M.S., Ph.D.,
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INTRODUCTION

The Hibiscus Mealybug, *Phenacoccus hirsutus* Green, is by far the most important species of mealybugs in this country. Although it was reported from Matariya, in the vicinity of Cairo, in 1912, it is probable that it had been introduced into Egypt some time in 1908 on some garden plants from India (Hall, 1921; Willcocks, 1937). By 1915 the pest had become very firmly established, spread right into Cairo and in the summer of 1918 caused devastations to a great many ornamental trees and shrubs. In spite of all efforts to check it, the species continued to spread until it covered the greater part of the cultivated area. Gradually, however, the population of the pest declined. To day, with the exception of some sporadic outbreaks here and there, it is safe to claim that the pest is under control. The decrease in the degree of infestation is, I believe, due chiefly to the action of its parasite, *Anagyrus kamali*, the biology and life history of which is outlined in this paper. Whether this species is indigenous or introduced is still debatable and will not be dealt with here.

DISTRIBUTION

Anagyrus kamali is widely distributed in Egypt. It was collected by the author from parasitised Hibiscus Mealybug at Alexandria, Mit Khalaf (Menoufia), Benha, Tura, Maadi, Giza, Mallawi, Naga Hammadi and Isna.

DESCRIPTION OF THE IMMATURE STAGES

Since this species is similar to *Anagyrus aegyptiacus*, only a brief description of the immature stages, their peculiarities and measurements will be dealt with here.

Egg

Ovarian egg: The ovarian egg (figs. 1-4) is a double bodied structure consisting of the egg proper, the bulb and the narrow stalk which connects them. Extending from near the base of the bulb along the stalk and almost the whole length of the egg proper is the aeroscopic plate. This plate almost surrounds the greater part of the stalk and looks as if it were superimposed on the surface of the egg, except at a certain region on the stalk where it underlies a thickened wall. The plate is a granular structure formed of a number of minute cells arranged in the same manner as illustrated in figures 3 and 4. These cells are larger and more widely separated at the upper end of the stalk, thus forming a spongy structure, the respiratory plug. Even at this stage the aeroscopic plate is darker in colour than the chorion and thus can be easily differentiated.

Deposited egg: The deposited egg (fig. 5) is almost oval in shape and exclusive of the stalk is almost twice as long as broad, being 0.114 mm. in length and 0.072 mm. in width. The stalk is 0.10 mm. in length. The egg lies free in the body cavity of the host attached to its wall by the stalk. The collapsed bulb and a portion of the stalk project a little distance outside the host wall as a minute thread.

The aeroscopic plate gradually gets darker in colour (figs. 6 and 7). Immediately after hatching the parts of this plate on the base of the stalk and around and near the points of contact with the spiracles on the egg proper appear black. Eventually, almost all the plate turns black. The chorion, however, does not undergo any appreciable change in colour until after the third moult when it becomes slightly brownish (fig. 13).

Hatching

Soon after deposition a deep yellowish zone becomes apparent at the middle of the egg and the outline of the embryo is marked; shortly thereafter the development of the embryo is completed (fig. 6). The stomodaeum lies at the cephalic end of the egg at the base of the stalk; the stomach appears

as a yellowish sac at the center and the respiratory system becomes visible. The posterior spiracles are attached to the egg shell at the center of the granulated band near the caudal end of the egg. In contrast with *Anagyrus aegyptiacus*, eclosion in this species seems to take place at the cephalic end of the egg near the stalk (fig. 7).

First instar larva

The first instar larva (fig. 7) measures about 0.224 mm. long and 0.08 mm. wide. The head is hemispherical, about 0.056 mm. wide and carries a pair of very small mandibles (fig. 12 A) about 0.013 mm. in length each.

At this stage segmentation of the body especially at the caudal end is not well marked and the body is still enclosed by its amniotic membrane, the trophamnion (fig. 8). The membrane is formed from very small cubital cells as illustrated in the figure.

The organisation of the alimentary and respiratory systems is the same as in *Anagyrus aegyptiacus*. This instar and the succeeding four are metapneustic; posteriorly each lateral tracheal trunk ends in a spiracle which is attached to the aeroscopic plate at approximately the same position as in the embryo (figs. 7 and 9).

At the end of this stage the larva attains a length of 0.40 mm. and a breadth of 0.088 mm.

At ecdysis of this instar and the succeeding four the skin is sloughed off to the posterior extremity of the body partially surrounding it and remains attached to the egg shell.

Second instar larva

This instar (fig. 10) is 0.40 mm. long. The head is 0.072 mm. wide and the mandibles (fig. 12 B) which are dark in colour are about 0.018 mm. long each. The body is now clearly segmented and exclusive of the head is formed from eleven segments. The tracheal branches appear on the mesothorax, the metathorax and the first six abdominal segments. The dorsal transverse commissure lies on the prothorax while the ventral commissure occurs on the tenth body segment.

Third instar larva

This instar (fig. 11) is 0.44 mm. long and 0.16 mm. wide. The head is 0.088 mm. wide and the mandibles (fig. 12 C) are 0.198 mm. long and 0.022 mm. wide at the base each. Eight pairs of short stub-like spiracular branches are evident; these arise from or near the points of connection of the tracheal branches with the main trunks.

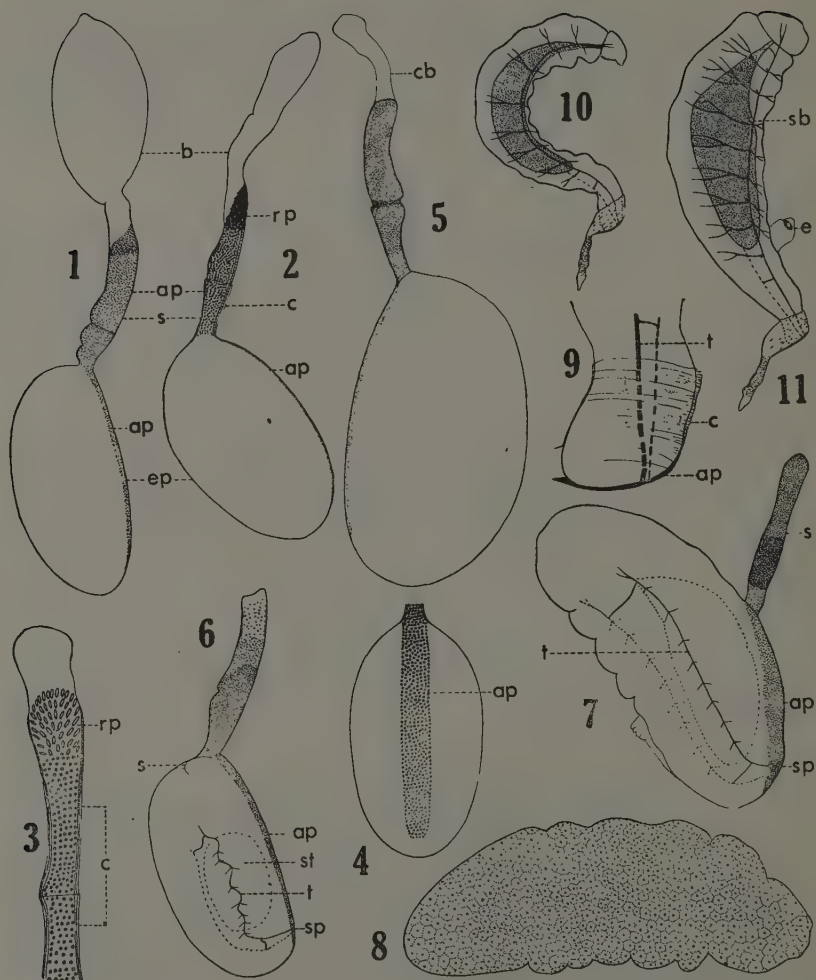


Fig. 1 : Ovarian egg in a comparatively early stage of development (*ap*, aeroscopic plate; *b*, bulb; *ep*, egg proper; *s*, stalk). — Fig. 2 : Same, in an advanced stage of development (*ap*, aeroscopic plate; *c*, thickened wall; *ep*, egg proper; *rp*, respiratory plug; *s*, stalk). — Fig. 3 : Stalk showing aeroscopic plate (*c*, thickened wall; *rp*, respiratory plug). — Fig. 4 : Egg proper, showing aeroscopic plate (*ap*, aeroscopic plate). — Fig. 5 : Deposited egg (*cb*, collapsed bulb). — Fig. 6 : Deposited egg, embryo completely formed (*ap*, aeroscopic plate; *s*, stomodaeum; *sp*, spiracle; *st*, stomach; *t*, lateral tracheal trunk). — Fig. 7 : First instar larva, just hatching (*ap*, aeroscopic plate; *s*, stalk; *sp*, spiracle; *t*, lateral tracheal trunk). — Fig. 8 : First instar larva enclosed by the trophamnion. — Fig. 9 : Caudal end of first instar larva showing close association of poste-

rior spiracles with aeroscopic plate (*ap*, aeroscopic plate; *c*, chorion; *t*, lateral tracheal trunk). — Fig. 10: Second larval instar. — Fig. 11: Third larval instar (*e*, exuvium of preceding instar; *sb*, spiracular branch).

Fourth instar larva

This instar measures about 0.88 mm. long and 0.28 mm. wide. The head is 0.104 mm. wide and the mandibles (fig. 12 D) are 0.0216 mm. long and 0.031 mm. wide at the base each.

Fifth instar larva

The head is 0.184 mm. wide and the mandibles (fig. 12 E) are 0.023 mm. long each. Eight pairs of non functional spiracles (fig. 19 E) appear on the mesothorax, the metathorax and the first six abdominal segments.

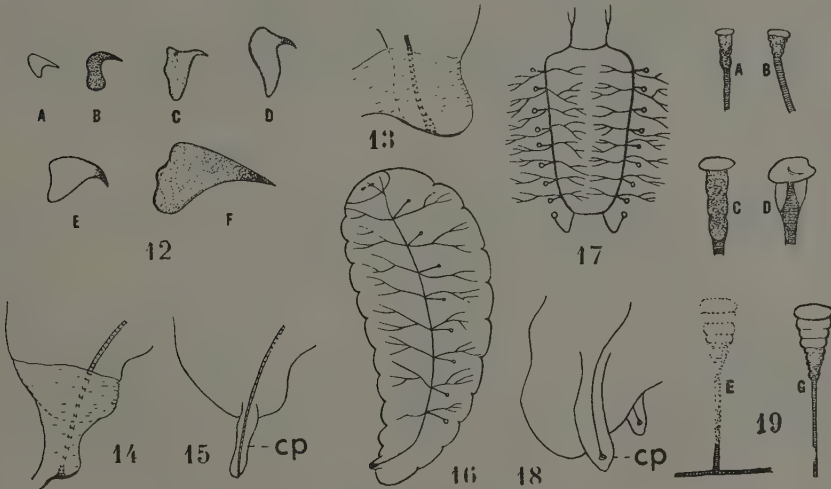


Fig. 12: A, B, C, D, E, F, mandibles of first, second, third, fourth, fifth and sixth larval instars. — Fig. 13: Caudal end of fourth instar larva showing spiracle closely attached to aeroscopic plate. — Fig. 14: Caudal end of fifth instar larva. — Fig. 15: Same, freed from chorion and persistent larval exuviae (*cp*, caudal process). — Fig. 16: Sixth larval instar showing arrangement of spiracles. — Fig. 17: Same, showing organization of respiratory system. — Fig. 18: Caudal end of same (*cp*, caudal process). — Fig. 19: A, B, C and D, posterior spiracles of third, fourth, fifth and sixth larval instars; E, incompletely developed thoracic spiracle, fifth larval instar; G, completely developed spiracle, sixth larval instar.

At this stage a pair of thin walled caudal processes appear at the posterior extremity of the last body segment, and carry the posterior spiracles at their distal ends. By this means the posterior spiracles do not lose their contact with the aeroscopic plate on the egg shell (figs. 14 and 15).

Sixth instar larva

This instar (fig. 16) is about twice as long as broad being 2.4 mm. long and 1.04 mm. wide. The head comes to lie on the ventral surface of the prothorax and is about 0.28 mm. wide. The mandibles (fig. 12F) are 0.036 mm. long each. It is at the beginning of this stage that the persistent egg shell and the larval exuviae are cast off and the caudal end of the body becomes thus free. All the spiracles become functional at least at the end of this stage. The posterior spiracles are still carried at the distal ends of two short caudal processes (fig. 18). The organisation of the respiratory system of this instar is illustrated in figure 17.

Prepupa and pupa

As in *Anagyrus aegyptiacus* and *Leptomastix phenacocci*, the prepupa of *Anagyrus kamali* lies in an amber yellow cocoon inside the dried body of the host with its head at the posterior end of the latter. During its change to the prepupa the stomach contents of the full grown larva are discharged at the anterior region of the host thus giving it its characteristic brown or black colour.

BIOLOGY

Emergence, mating, oviposition, superparasitism and secondary parasitism are similar to those of *Anagyrus aegyptiacus*.

Life cycle

The life cycle varies with temperature and stage of the host attacked. At a temperature of 25°C. the life cycle from egg to adult takes about 18 days with 4 days incubation, 2 days for the first larval stage, 3 days for the second, 2 days for the third, one day for the fourth, 3 days for the fifth and sixth larval stages, and 3 days for the prepupal and pupal.

Sex ratio

The sex ratio is almost 1:1. Out of 340 insects collected in the field in September 1946 from Hibiscus Mealybug infesting til (*Hibiscus cannabinus* L.), 171 were males and 169 were females.

Longevity of adults

The adult insect can live for several months especially in winter time. Three females emerging on 15.i.1945 died after 37, 79, and 89 days respectively. One male and six females emerging on 11.i.1945 died after 48, 83, 96, 105, 110, 131 and 131 days respectively. Seven females emerging on 17.ii.1946 died after 58, 67, 70, 80, 80, 80, and 83 days respectively.

Stage of the host attacked

Male and female hosts in their first and second nymphal instars are readily attacked; male prepupae and pupae and ovipositing females are not attacked. While embryonic development is not affected, the first larval stage of the parasite is prolonged when first instar nymphs of the parasite are used in breeding. When parasitised in their late second nymphal instar, host females may lay very few eggs before they are completely destroyed.

Adult parasites vary in size as to the sex of their hosts. Adults bred in female hosts are larger in size than those bred in male hosts.

Seasonal history

When 16 to 20 days old host nymphs are used in breeding the cycle of the parasite from egg to adult takes about 18 days. Under such conditions there are from two to three generations of the parasite for every host generation. The number of generations in the field, however, will depend upon the availability and age of the host. The Hibiscus Mealybug passes the winter chiefly in the egg stage; but few nymphs of various stages of development as well as adults are always available at this time of the year. It has already been indicated that the parasite can live for several months in the adult stage. Furthermore, it was shown that adults kept in captivity for 42 days will readily lay eggs when suitable host material is provided. All these facts would seem to suggest that the parasite does not meet much difficulty in overcoming the mild winter months. Parasites were seen to emerge in variable numbers from host material collected in the vicinity of Cairo and kept outdoors during the months of December, January, February and March. With the advent of summer months, rise in temperature and increase in the activity and population of the host, the parasite population builds up until it reaches its peak in September and October when parasitism by this species is at its highest.

ECONOMIC IMPORTANCE

Only in recent years has the role of parasites in the control of the Hibiscus Mealybug received much attention. *Anagyrus kamali* was observed to be the commonest and most effective parasite of the pest in this country. It emerges in appreciable numbers from host material collected in different months of the year, especially in August, September and October. The number of parasitised and non parasitised last stage female hosts were counted in specimens collected during the months of September and October at different localities. The percentage of parasitism was 66 in a til infesting specimen collected at Giza in September, and 87.2 in another til (*Hibiscus cannabinus*) and bamia (*Hibiscus esculentus*) infesting specimens

collected at the same locality in the same month. Parasitism was 75 % in a *bamia* infesting specimen collected at Benha in September and almost 100 % in each of two other Guava and custard apple infesting specimens collected at Giza in October.

SUMMARY

Anagyrus kamali is widely distributed in Egypt; it is the most important parasite of the Hibiscus Mealybug, *Phenacoccus hirsutus*, and destroys from 80 to 100 % of the population of the pest late in the season. There are six larval instars; the first is surrounded by the trophamnion. The caudal ends of the first five instars are enclosed by the egg chorion and by the persistent exuviae of the preceding instars. The caudal ends of the fifth and sixth instars are provided with a pair of caudal processes each which carry the posterior spiracles at their distal ends. Biology is similar to that of *Anagyrus aegyptiacus*. Population of the parasite is at its minimum in winter time and at its maximum in October.

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- Willcocks, F.C., and Bahgat, Said (1937) : The insect and related pests of Egypt, Vol. 1:2, pp. 382-396 (published by the Royal Agricultural Society).
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CONTRIBUTIONS TO THE KNOWLEDGE
OF THE NATURAL ENEMIES OF MEALYBUGS

3.

Anagyrus ægyptiacus Moursi,
a Parasite of the Lebbek Mealybug,
Pseudococcus filamentosus Ckll.

[Hymenoptera : Encyrtidae]

(with 31 Text-Figures)

by A.A. MOURSI, B.Sc., M.S., Ph. D.,
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INTRODUCTION

Mealybugs comprise some of the worst pests of fruit and shade trees in many parts of the world especially in tropical and sub-tropical countries. The Lebbek Mealybug (*Pseudococcus filamentosus* Ckll.) is one of the commonest and of the best known species in this country. In the summers of 1907 and 1909 it caused great devastations to Lebbek trees in Cairo. In 1909, about one third of the trees were virtually destroyed and had to be replanted with other species of shade trees more resistant to the pest.

The author is indebted to his colleagues M. M. Ibrahim and M. Hafez for valuable assistance and useful remarks.

PARASITES OF THE LEBBEK MEALYBUG

Mealybugs as a group seem to be especially susceptible to attack by insect enemies of various kinds. Their habits of feeding in clusters in unprotected situations render them easily accessible to parasite and predatory insects. The most efficient parasites of the Lebbek Mealybug in Egypt are : *Anagyrus ægyptiacus* Moursi, *Leptomastix phenacocci* Compere and *Ace-rophagus* spec.. The biology of the first species is outlined in this paper.

MATERIAL, METHOD AND TECHNIQUE

In order to study the parasites of mealybugs, it is necessary to breed them in the laboratory. In the breeding of parasites the production of a suitable host plant of the insect pest and the breeding of that pest on that host are preliminary steps for the production of the parasite. Thus the discovery of the adaptability of the potato sprout to the rearing of mealybugs by Smith and Armitage (1920) was a long step toward assuring not only the possibility of studying the mealybug predators and parasites but also their mass production in the laboratory.

The Lebbek Mealybug is easily reared on potato sprouts (figs. 1 and 2). For the purpose of obtaining a relatively big population of the insect, the potatoes are cultivated in pots and infested with the mealybug when the sprouts are big enough to carry an infestation. From three varieties of potatoes (Arran Pilot, Up to Date, and Arran Banner), the first proved most satisfactory for our purposes; since it gives stout erect sprouts. The pots containing infested sprouts are placed with the parasites in cages $30 \times 30 \times 35$ cms. Each cage has a wooden frame and bottom, the top and three side walls are covered with a very fine wire screen. A movable glass door runs up and down into two lateral grooves on the fourth side wall of the cage. After being exposed to the parasites for two or three days, the pots are removed and placed in other cages, the emergence cages.

Large colonies of the pest were also obtained when pumpkin fruits (*Cucurbita pepo*) were used as host plants.

DESCRIPTION OF THE IMMATURE STAGES

Egg

Ovarian egg

The ovarian egg (fig. 3) is a double bodied structure. It consists of the egg proper, the bulb and of a narrow stalk between them. The stalk is attached at the end of the egg proper and slightly to one side so that laterally the egg appears to be more or less convex on one side, whereas from the dorsal or ventral aspect it is centrally located. Extending from the base of the bulb, along the stalk and almost the whole length of the egg proper is a granulated band, the aeroscopic plate (figs. 3-6) which looks as if it were superimposed on the surface of the egg. At this stage the granulated band on the egg proper is difficult to see. The band on the stalk is a narrow elongate structure which measures about 0.23 mm. in length and 0.01 mm. in breadth, while it is 0.14 mm. in length and 0.02 in breadth on the egg proper. The band covers one side of the stalk except at the junction of the latter with the egg proper at which point it almost

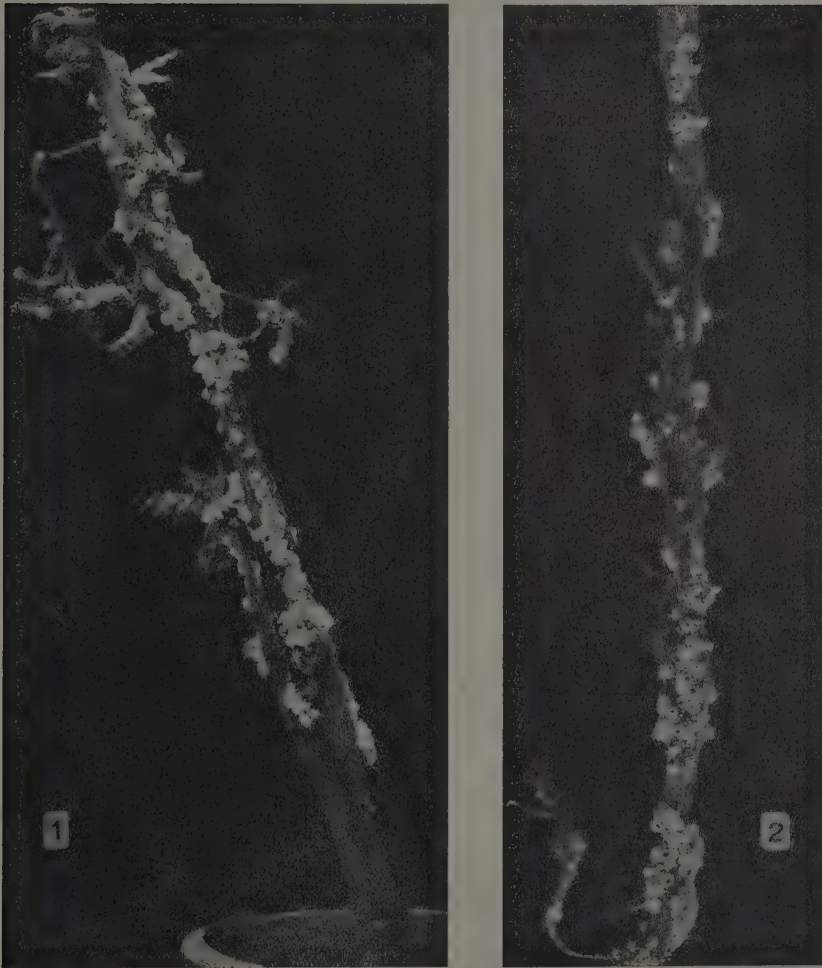


Fig. 1 : Method of rearing the Lebbek Mealybug (*Pseudococcus filamentosus* Ckll.) on potato sprouts. — Fig. 2 : Host insects showing emergence holes of the parasites.

completely surrounds the stalk. Except at a very small region (*aa*), the granulated band is on the outer surface of the stalk. At this region the band underlies a thickened wall. The band is composed of mosaic of cells distributed in the same manner as illustrated in figures 3-6. These cells are larger and looser at the distal end of the stalk thus forming a porous or spongy structure which was termed by Silvestri the respiratory plug.

Deposited egg

During oviposition the contents of the bulb are forced into the egg proper. The egg lies free in the body cavity of the host attached to its wall by the long slender stalk; the collapsed bulb together with a portion of the stalk (fig. 7) are left protruding as a minute thread outside the host body; and by this means a connection with the outside air is maintained. The body wall of the host surrounds the stalk at the thickened region (*aa*).

Soon after deposition the granulated band turns grey and is easily differentiated from the chorion of the egg; in due course it turns black. Melanization commences on that part of the granulated band between the region *aa* on the stalk and the points of attachment of the posterior spiracles of the developing larva with the aeroscopic plate on the egg proper, this region is black when other parts of the aeroscopic plate are still grey (fig. 15). In due course the chorion of the egg also turns black; melanization commences on that part of the chorion of the egg proper nearer to the stalk (fig. 16).

It may be of interest to note that the cells of the aeroscopic plate of a newly dissected ovarian egg are difficult to see, but they turn grey and are easily differentiated when the eggs are left for twenty minutes in a physiological salt solution or when exposed to atmospheric air for two or three minutes.

The deposited egg is oval in shape. Exclusive of the stalk, it is almost twice as long as broad, being 0.18 mm. long and 0.08 mm. wide. The stalk is again 0.24 mm. long, and 0.01 mm. wide.

Hatching

Immediately after deposition the contents of the egg are homogenous and translucent white but as incubation proceeds a deep yellowish zone becomes apparent in the middle and the outline of the embryo is marked. Shortly thereafter, the development of the embryo is completed, the head and eleven body segments become clear and distinct, the longitudinal tracheal trunks, the transverse commissures and the segmental tracheal branches are visible and easy to detect (figs. 8 and 9). The alimentary canal (fig. 29) is seen to consist of a narrow tubular pharynx which opens into a sac-like stomach. The latter contains a certain amount of yolk and is closed at its connection with the hind gut. This organ is widened at its base to form a funnel shaped structure. The ileac glands are attached to the base of the hind gut and the long convoluted salivary glands on both sides of the alimentary canal.

At this stage the head of the embryo is at the cephalic end of the egg, but then the embryo begins to move and just before hatching its head comes

to lie at the free end of the egg, the caudal end, at which region eclosion occurs (fig. 10).

Incubation period takes about four days at a temperature of 25° C.

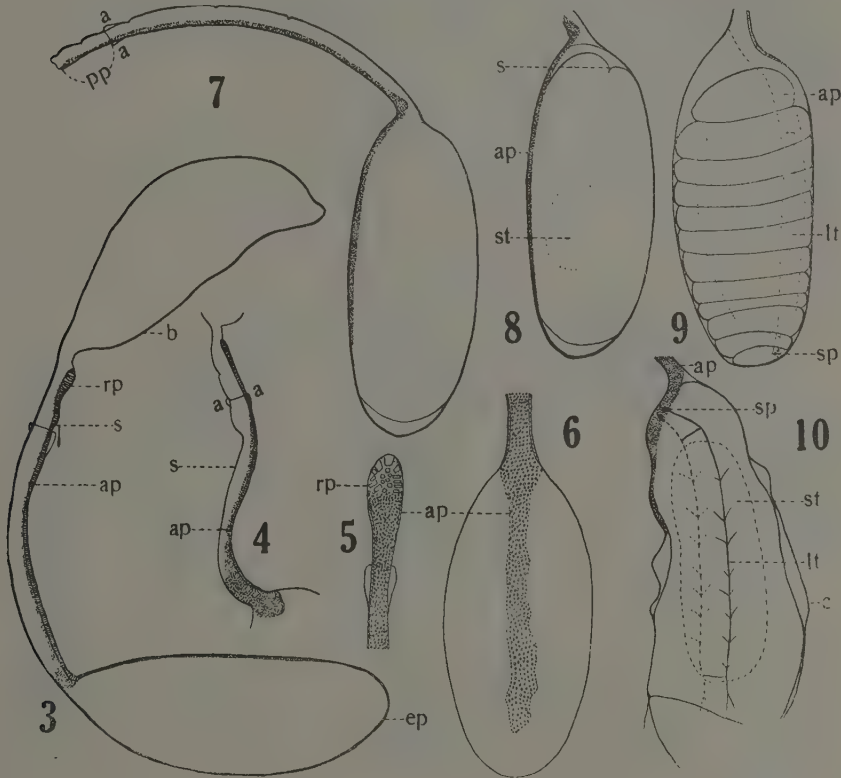


Fig. 3 : Ovarian egg (*ap*, aeroscopic plate; *b*, bulb; *ep*, egg proper; *rp*, respiratory plug; *s*, stalk). — Fig. 4 : Stalk of same (*aa*, thickened region). — Fig. 5 : Distal end of stalk, ventral view (*aa*, thickened region; *ap*, aeroscopic plate; *rp*, respiratory plug). — Fig. 6 : Egg proper of same (*ap*, aeroscopic plate). — Fig. 7 : Deposited egg (*aa*, thickened region; *pp*, collapsed bulb and portion of stalk outside host). — Fig. 8 : Same, embryo partially developed (*ap*, aeroscopic plate; *s*, stomodaeum; *st*, stomach). — Fig. 9 : Same, embryo completely developed (*ap*, aeroscopic plate; *lt*, lateral tracheal trunk; *sp*, spiracle). — Fig. 10 : Eclosion of larva (*ap*, aeroscopic plate; *c*, egg chorion; *lt*, lateral tracheal trunk; *sp*, spiracle; *st*, stomach).

First instar larva

Immediately after hatching the larva sustains a length of 0.22 mm. and a breadth of 0.08 mm. The head is rounded and hemispherical and almost as long as broad being 0.07 mm. wide. It carries a pair of very short truncate

antennae on its latero-dorsal surfaces; each is 0.01 mm. in length. The body exclusive of the head is formed of eleven segments, but segmentation among the last two or three segments is not so well marked. The larva protrudes from the free end of the egg, its last four or five segments remain enclosed by the persistent egg chorion. The body is translucent white, except for the stomach which appears yellowish due to its yolk contents (figs. 9 and 10).

At this stage the larva is still enclosed by its embryonic membrane, the trophamnion. This membrane is formed from very small cubital cells measuring about 0.004 mm. in diameter each. The larva soon cuts through the membrane in the mouth region and begins feeding. The membrane persists around the body, however, until the first moult, or even after this moult during the second instar. The persistence of the embryonic membrane as an envelope partially or completely surrounding the first instar larva has been noted in many Braconids. It has also been noted by Clancy (Clausen, 1940) in the Encyrtid *Chrysopophagus compressicornis* Ash. An embryonic membrane was also noted by the author to persist around the first instar larvae of the Encyrtids *Anagyrus kamali*, *Leptomastix phenacocci*, and *Acerophagus* spec., a parasite of the Lebbek Mealybug. This phenomenon seems to be more common than it is usually reported. The amniotic membrane is thought to play a role in the elaboration of the food materials from the host body fluids and passing them to the parasite.

The alimentary canal consists of the mouth which is a wide opening on the ventral surface of the head; on each side of the mouth is a small slightly pigmented mandible (fig. 28 A) about 0.016 mm. long and 0.014 mm. wide at the base each. The mouth leads to a narrow tubular pharynx which traverses the first thoracic segment and opens into a dilated blind sac, the stomach. With the intake of food materials the stomach assumes the colour of the body fluids of the host. The stomach is closed at its connection with the hind gut.

Immediately after eclosion, the tracheae are transparent and difficult to discern, but shortly afterwards they become slightly darker and apparent. The tracheal system consists of two main longitudinal trunks which extend along the sides of the body and give off pairs of minute branches on the mesothorax, the metathorax and the first six abdominal segments. The two trunks are connected by two transverse commissures, a dorsal commissure on the first thoracic and a ventral commissure on the seventh abdominal segment. Anteriorly each trunk gives off a pair of branches to the head.

At this instar and the succeeding three the tracheal system is meta-pneustic; each lateral main trunk ends in a spiracle at the posterior end of the body. In this instar and the following four the posterior spiracles are

attached to the egg shell at the center of the granulated band near the stalk (fig. 10). By this device the larva establishes a direct contact with the outside air. In his excellent paper on *Oöencyrtus johnsoni* (Howard) Maple (1937) gives a detailed account of the role of the granulated band, the aeroscopic plate, as a means of obtaining atmospheric air in certain Encyrtid larvae. In contrast with many early authors, he concludes that the banded structure found on the eggs of certain species and not the hollow stalk serves to conduct atmospheric air for the respiration of the larva. Maple presents six evidences in support of his hypothesis. He further points out that it has yet to be conclusively proved that the larvae respire atmos-

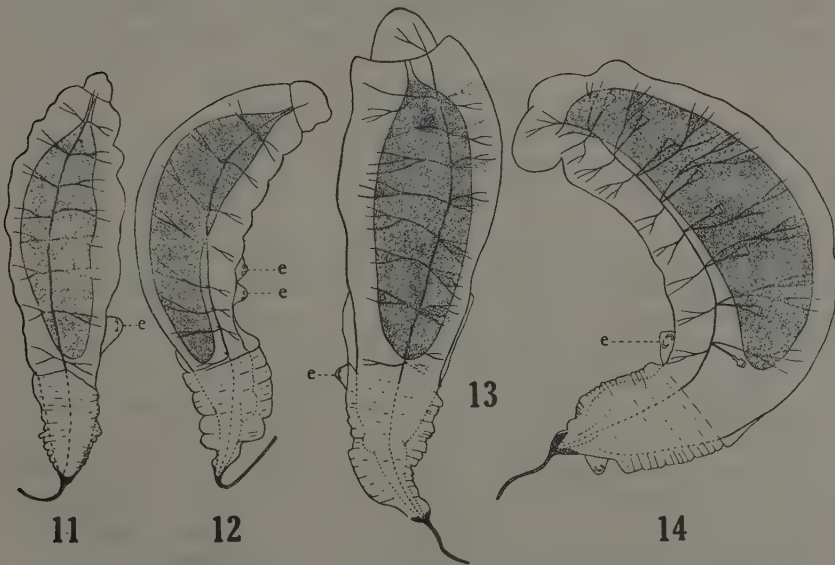


Fig. 11 : Second larval instar (e, exuvium). — Fig. 12 : Third larval instar (e, exuviae). — Fig. 13 : Fourth larval instar (e, exuvium). — Fig. 14 : Fifth larval instar (e, exuvium).

pheric air or even require it for development. Sufficient air may be derived by diffusion from the fluids of the host through the aeroscopic plate and then into the spiracles.

At the end of this stage the larva attains a length of 0.8 mm. and a breadth of 0.14 mm. with an increase of approximately four times in length and two times in width during this stadium, which lasts about four days at a temperature of 31°C.

At ecdysis of this instar and the following four, the exuvium is sloughed

off to the posterior extremity of the body partially surrounding it and remains attached to the egg shell.

Second instar larva

This instar (fig. 11) has the same general organisation of the first instar larva. The head is a little shorter and broader than in the preceding instar, being 0.06 mm. long and 0.11 mm. wide. It is more or less hemispherical and apparently twice as wide as long. The antennae are no longer evident; and the mandibles (fig. 28 B) are little longer and wider, being 0.018 mm. long and 0.016 mm. wide each. The spiracles are firmly attached to the egg chorion at approximately the same position as in the first instar. At this stage the egg chorion turns dark grey (fig. 16). At the end of the stage the larva measures 1.20 mm. in length, and 0.23 mm. in width.

Third instar larva

This instar (fig. 12) is little broader than the preceding, being 0.40 mm. wide; the head is also longer and broader, being 0.10 mm. long and 0.14 mm. wide; the mandibles are 0.023 mm. long, and 0.027 mm. wide each (fig. 28 C).

At this stage each main tracheal trunk gives off eight stub-like spiracular branches which arise from or near the points of connection of the tracheal branches with the main trunks. The posterior end of the larva remains enclosed in an envelope formed from the egg shell and the first and second larval exuviae which push the egg shell a little distance from the body. But the spiracles are still in contact with the aeroscopic plate at approximately the same position as in the previous instar, though not as firmly attached. The main tracheal trunks give off a pair of long caudal spiracular stalks which are enveloped in a pair of thin walled spear-shaped caudal processes (fig. 17), measuring about 0.14 mm. long each. These caudal processes arise from the lateral extremities of the last body segment and carry the spiracles at their distal ends. By this adaptation the posterior spiracles are brought in contact with the aeroscopic plate on the chorion of the egg. Similar caudal processes were observed by Thorpe (1936) in *Encyrtus infelix*. In this species, however, the caudal processes were noted to arise from the tenth postcephalic segment.

Fourth instar larva

This instar (fig. 13) is 2.08 mm. long, and 0.64 mm. wide. The head is little shorter and broader than that of the preceding, being 0.096 mm. long, and 0.22 mm. wide. The mandibles (fig. 28 D) are 0.032 mm. long and 0.025 mm. wide each. The caudal processes have the same general appearance of those of the previous instar, each is 0.32 mm. long (fig. 18)

Eight pairs of non functional spiracles (fig. 23) become evident on the mesothorax, the metathorax and the first six abdominal segments.

Fifth instar larva

This instar (fig. 14) is not much longer than the preceding; the head, however, is little wider being 0.36 mm. wide. The mandibles (fig. 28 E) are slightly pigmented at their tips, each is 0.040 mm. in length, and 0.036 mm. wide. The caudal processes are little shorter than those of the previous instar, being 0.198 mm. in length each (fig. 19).

The posterior spiracles are still in contact with the aeroscopic plate at approximately the same position as in the previous instars. The other spiracles are now completely developed (fig. 24); but the body of the parasite is still surrounded with the host body fluids and the spiracles have no access to free air.

Sixth instar larva

This instar (fig. 31) is almost three times as long as broad, being 2.00 mm. long and 0.72 mm. wide. At this stage the head comes to lie on the ventral surface of the prothorax. The mandibles (fig. 28F) are 0.040 mm. long, and 0.030 mm. wide each.

A short time after this stage has begun, the posterior envelope, formed from the egg shell and the exuviae of the previous instars which, so far, have persisted around the caudal end of the body, is completely cast off and this end of the body becomes free. The caudal processes appear as short anteriorly directed processes on the last body segment; about 0.24 mm. long each. The posterior spiracles differ both in function and structure from the other spiracles (figs. 20, 21, 22, and 25), being functional only at the beginning of the stadium; they become non functional, however, at the end of the stadium when the spiracular branches connecting them with the main tracheae collapse.

While still surrounded with the host body fluids, the sixth instar larva becomes surrounded with a thin walled cell or cocoon. This, it is claimed, serves as a means for providing the larva with an adequate supply of oxygen and as a device for its protection against the host body fluids. Portions of the host tracheae are incorporated in the walls of the cocoon and in due course openings occur at the tracheal attachments. The larva then shrinks and a space is formed between the body of the parasite and the wall of the cocoon. Air is pulled in to fill that space and the spiracles have now access to atmospheric air.

Cocoon

The cocoon is formed primarily from secretions of the ileac and salivary glands which are very well developed at this stage (fig. 26). Flanders

(1938) discussing the origin of this cocoon concludes that the ileac and salivary glands are apparently identical in function and that they produce a viscid material which exudes from both ends of the body, mouth and anus, and spreads to form a thin protective covering. This cell is consequently

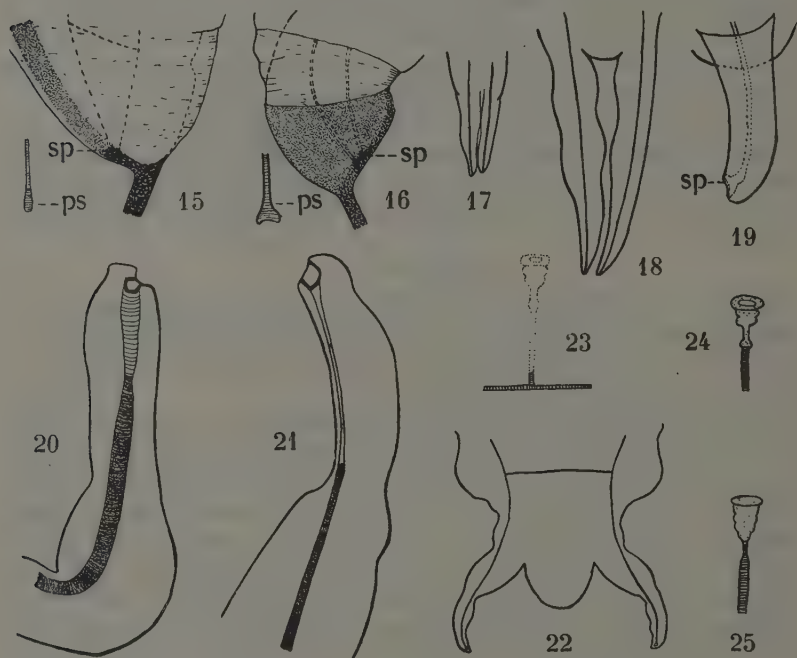


Fig. 15 : Caudal end of first larval instar (*sp*, spiracle; *ps*, posterior spiracle, magnified). — Fig. 16 : Caudal end of second larval instar (*sp*, spiracle; *ps*, posterior spiracle, magnified). — Fig. 17 : Caudal processes of third larval instar. — Fig. 18 : Caudal processes of fourth larval instar. — Fig. 19 : Caudal process of fifth larval instar (*sp*, spiracle). — Fig. 20 : Caudal process of sixth larval instar very highly magnified. — Fig. 21 : Same, at the end of the stage showing the beginning of collapse of the distal end of the trachea. — Fig. 22 : Caudal end of sixth larval instar compressed to show points of origin of caudal processes. — Fig. 23 : Incompletely developed thoracic spiracle, fourth larval instar. — Fig. 24 : Thoracic spiracle, fifth larval instar. — Fig. 25 : Thoracic spiracle, sixth larval instar.

a cocoon, in film form rather than composed of strands and is identical in origin with the common spun cocoon. Soon after its formation the viscous liquid is hardened to form a membranous, amorphous and brittle sheath which acquires a brown red or amber yellow colour. The characteristic dark yellow appearance of the parasitised host is due to the colour of this cocoon.

Cases where two full grown larvae occur in a single host are not very common; in such cases, however, each larva has its own cocoon.

Prepupa and Pupa

When in its last larval stage the parasite lies within the host body ventral side downward with the head end at the posterior extremity of the host. In all cases where two full grown larvae are present in a single host, both larvae have the same orientation.

The larva then shrinks, the stomach opens into the hind gut, the

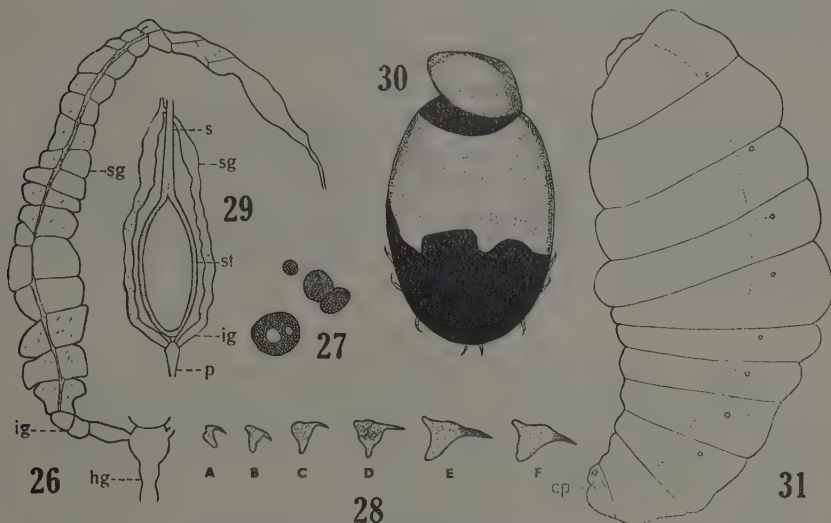


Fig. 26 : Ileac and salivary glands, sixth larval instar (*hg*, hind gut; *ig*, ileac gland; *sg*, salivary gland). — Fig. 27 : Fat body cells, sixth larval instars. — Fig. 28 : A, B, C, D, E, and F, mandibles of first, second, third, fourth, fifth and sixth larval instars. — Fig. 29 : Alimentary canal of completely developed embryo (*ig*, ileac gland; *p*, proctodaeum or hind gut; *s*, stomodaeum; *sg*, salivary gland; *st*, stomach). — Fig. 30 : Host insect after emergence of parasite. — Fig. 31 : Sixth larval instar showing arrangement of spiracles (*cp*, caudal process).

stomach contents are discharged out and the whole body looks whitish opaque, this is the prepupal stage. It is the stomach contents thus discharged that give the characteristic dark patch at the anterior region of the mummified host (fig. 30). At the end of this stage the parasite moults another time and the pupa is formed.

BIOLOGY

Effect of the Parasite on the Host

The first stage larva of the parasite is small provided with weak and slightly sclerotised mandibles. It feeds on the body fluids of the host and

cannot do any considerable damage. The later stages, however, are much more effective, and it is the last stage larva that does the most considerable damage. It feeds much more extensively, devours the interior viscera and other vital organs including the internal organs of the head that by the end of this stage the host changes into a thin walled case, containing the parasite, lined from the inside by the amber yellow thin walled parasite cocoon.

The mummified body of mealybug destroyed by *Anagyrus* is thus amber, dirty yellow or brown red in colour with a dark patch at its anterior or cephalic end. The waxy filaments or powder that cover it may, however, be retained even after the emergence of the parasite.

Emergence and Mating

Males of the parasite complete their development before the females. Emergence takes place inside the cocoon and adults make their way out by pushing a cap-like operculum at the anterior end of the host body (fig. 30). When two parasites are present emergence is effected through separate openings, also at the anterior end. Mating takes place immediately after emergence and is usually very quick.

Life cycle

The duration of the life cycle varies with temperature and stage of host attacked. It is 28 days at a temperature of 25°C., and 16 days at 31°C. Under the last condition of temperature it takes the host 47 days to complete its cycle. Generally, however, there are from two to three generations of the parasite for every host generation.

Sex ratio

The sexes are equally represented, the sex ratio being 1:1 among parasites collected in the field or reared in the laboratory.

Oviposition

The ovaries of adult insects are formed from three ovarioles each. Oogenesis begins in the pupal stage and newly emerged females contain partially developed eggs in their ovaries. Oviposition takes place, however, few days after emergence. This process is rather quick, it takes only few seconds; and only one egg is laid at each insertion. It may be of interest to note that adult insects kept in captivity for three weeks will readily lay eggs when provided with suitable host material.

Stages of host attacked

The parasite shows predilection to the first, second and early third instars of the host. Male prepupae and pupae and egg laying females are

not attacked. Embryonic development is unaffected by the stage of the host, but the first larval stage of the parasite may be prolonged when parasite eggs are deposited in first instar nymphs of the host. Adult parasites that complete their development in male hosts are smaller in size than those that develop in female hosts. This may account for the great variation in size among adults.

Superparasitism and multiple parasitism

Normally, one egg is deposited in a host. It seems, however, that female parasites do not distinguish between parasitised and non parasitised hosts and consequently a host may be attacked more than once by the same female or by different females of the same or different species. A host insect may thus contain more than one parasite. Generally all deposited eggs will hatch, but only one parasite will complete its development. It is not very uncommon, however, that two parasites may complete their development in a single host; nor is it unusual that immature stages of *Anagyrus aegyptiacus* and of *Leptomastix phenacocci* are encountered in the same host, when the latter is collected in the field or exposed to females of both species in the laboratory.

Secondary parasitism

A *Pachyneuron* spec. (Pteromalidae), was noticed to emerge from hosts parasitised with *Anagyrus aegyptiacus*. This secondary parasite was observed to lay eggs and complete its development on the newly formed pupae of the primary parasite. Several individuals of the Pteromalid may complete their development on a single pupa. They make their way out of the mummified mealybug through holes that they eat in its wall. Generally, each individual emerges through a separate opening. The Pteromalid was observed to emerge in large numbers from mealybug material collected in the field when parasitism by *Anagyrus* is at its highest. The population of the secondary parasite seems to be in direct proportion with that of the primary.

Longevity of adults

Longevity of adults varies with the season. Two males and three females emerging on 19.i.1945 died after 36, 62, 50, 71, and 85 days respectively. One female emerging on 12.xii.1944 died after 113 days.

Number of generations per year

We have seen that under laboratory conditions there are generally from two to three generations of the parasite for every host generation. Under field conditions, however, the number of generations per year will depend

upon the availability and age of the host. When the host is available the parasite will reproduce generation after generation without interruption. Indeed, there is no need for synchronization of the cycles of the host and of the parasite. The hatching of the host is not exactly even and stages of the host suitable for parasitism are almost always available. This is also the case even in winter months when the population of the host is at its minimum and the egg stage is more predominant.

Overwintering

Under our mild winter conditions, the parasite can, to a certain extent, remain active. Collections of mealybug parasitised material in the vicinity of Cairo were made every fifteen days during the months of December, January, February and March. The material was put in cages and kept outside the laboratory, but the parasites were still able to emerge, from the material thus collected, under the cold climatic conditions prevailing outdoors at this time of the year. It is interesting to remark that under such conditions the parasites could live for several months and that insects kept in captivity for 21 days will readily lay eggs when suitable host material is provided. It has also been noted that stages of the host suitable for parasitism are available, though in very small numbers at this time of the year. These facts would seem to suggest that the parasite does not meet great difficulty in overcoming the winter months.

Seasonal abundance

Contrary to what many would believe the Lebbek Mealybug does not exactly hibernate during the winter months. Only the insect becomes less active, development is retarded, the cycle is prolonged and the population becomes proportionately very low. This is also the case with its parasite *Anagyrus aegyptiacus*. With the advent of summer months and rise in temperature, the mealybug becomes more active, its cycle is shortened and it begins to build up a big population which reaches its peak late in the season, in August, September and October. The population of the parasite follows exactly the same trend except that its peak comes a little later. It is at its lowest in January and February, begins to rise in June and reaches its maximum in September and October.

Economic importance and interrelation of the parasites

Of the parasites that parasitise the Lebbek Mealybug, *Acerophagus* spec., *Anagyrus aegyptiacus*, and *Leptomastix phenacocci* are the most important. While the three species might attack the pest in its first nymphal instar, adults of *Acerophagus* emerge from this or the early second instar while adults of *Leptomastix* and *Anagyrus* emerge only from adult female

or prepupae of male hosts. *Acerophagus* plays an important role in the destruction of a good deal of first instar host nymphs; but owing to its minuteness, it is bound to be overlooked and its role as an important parasite of the pest is underrated. This species is very common in winter months and early in the season.

Parasitism by *Leptomastix* and *Anagyrus* is at its highest, however, late in the season when it is as high as 80 or 90 %. Competition exists between the two species and at times parasitism by one of them may be greatly lowered without any material alteration in the total percentage of parasitism. In 1946, parasitism by *Anagyrus* was exceptionally low, but that by *Leptomastix* was exceedingly high. In 1947 a low percentage of parasitism by *Leptomastix* was compensated with a high percentage of parasitism by *Anagyrus*.

SUMMARY

Anagyrus aegyptiacus is an important parasite of the Lebbek Mealybug, *Pseudococcus filamentosus*. In combination with *Leptomastix phenacocci* it destroys up to 80 or 90 % of the population of the pest at the end of the season. There are six larval instars; the first is surrounded by the trophamnion. The caudal ends of the first five instars are enveloped by the egg chorion and by the persistent exuviae of the preceding instars. The caudal ends of the third, fourth, fifth and sixth larval instars are provided with a pair of caudal processes each which carry the posterior spiracles at their distal ends. Life cycle varies with temperature and stage of the host attacked. There are generally two to three generations of the parasite for every host generation. While embryonic development is not affected, the first larval stage is prolonged when young hosts are used. Adults vary in size; those bred from male hosts are smaller in size than those bred from female hosts. Emergence takes place by pushing a cap-like operculum at the caudal end of the host. Sex ratio is 1:1; mating takes place immediately after emergence and oviposition commences very few days later. More than one egg is deposited in a single host, but generally only one parasite reaches maturity. Immature stages of *Anagyrus aegyptiacus* and *Leptomastix phenacocci* may occur in the same host. Pupae of *Anagyrus aegyptiacus* may be attacked by the Pteromalid, *Pachyneuron* spec.. Adults may live for several months and the parasite does not encounter great difficulty in overcoming the winter months. The population of the parasite is at its minimum in winter time and reaches its peak in September and October.

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CONTRIBUTIONS TO THE KNOWLEDGE
OF THE NATURAL ENEMIES OF MEALYBUGS

4.

Leptomastix phenacocci Compere,
a Parasite of the Lebbek Mealybug,
Pseudococcus filamentosus Ckll.

[Hymenoptera : Encyrtidae]

(with 22 Text-Figures)

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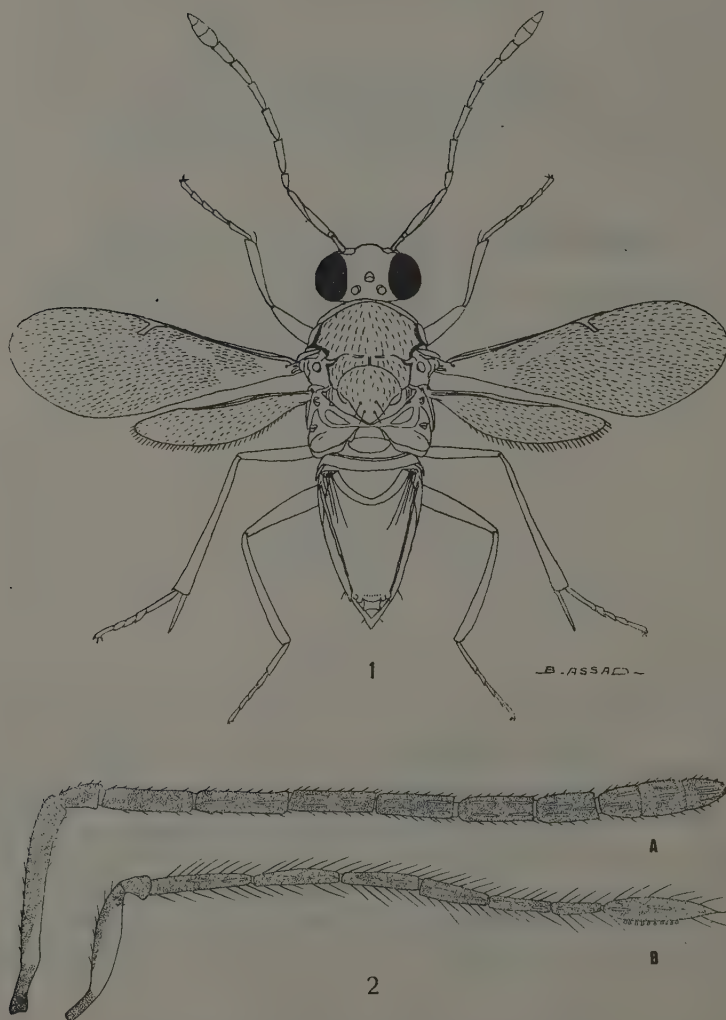
INTRODUCTION

Leptomastix phenacocci Compere (figs. 1 and 2) is one of the most important parasites of the Lebbek Mealybug in Egypt. It emerges in large numbers from host material collected in the field especially late in the season. The species was described by Compere (1938) from material received from Prof. H. Priesner of the entomological section. The material used in this work was identified by Dr. Ch. Ferrière of the Natural History Museum, Genève, Switzerland, to whom the author is very much indebted.

In my paper published in this Bulletin (pp. 17-32), I discussed the method and technique employed in the studies of mealybug parasites and only reference should be made.

DESCRIPTION OF THE IMMATURE STAGES

Since this species is similar to *Anagyrus aegyptiacus* Moursi which has already been studied in a little bit detail, only a brief description of the immature stages, their measurements and peculiarities will be dealt with here.



Leptomastix phenacocci Compere

Fig. 1 : Adult female, $\times 30$. — Fig. 2 : A, female antenna; B, male antenna.

Egg**Ovarian egg**

The ovarian egg is a double bodied structure consisting of the egg proper, the bulb and a narrow stalk connecting them (fig. 3). Extending from the base of the bulb along the stalk and almost the whole length of the egg proper is the aeroscopic plate which is very difficult to see at this stage on the egg proper. The aeroscopic plate is granular in appearance and formed from minute cells distributed in the same manner as illustrated in figures 5 and 6. These cells are little larger and looser at the upper end of the stalk thus forming a spongy porous structure, the respiratory plug. The aeroscopic plate covers only one side of the stalk and looks as if it were superimposed on the surface of the egg.

Deposited egg

The deposited egg (fig. 7) is oval in shape, and exclusive of the stalk is almost twice as long as broad being 0.18 mm. long and 0.096 mm. wide. The stalk is again 0.096 mm. long. The egg lies free in the body cavity of the host attached to its body wall by the long stalk which projects, as a minute thread, a little distance outside. Soon after deposition the aeroscopic plate turns gray and is easily differentiated from the rest of the chorion. In due course the plate and the chorion turn black (figs. 9, 10, and 11).

First instar larva

Soon after hatching, the larva (figs. 8 and 9) measures about 0.28 mm. in length and 0.096 mm. in width. At this stage the body is still enclosed by the trophamnion which consists of very small cubital cells. The larva soon cuts through this membrane in the mouth region and begins feeding, but the membrane remains about the body, however, until the first moult. The larva is of the encyrtiform type consisting of a head and eleven body segments; the last four or five segments are not clearly segmented and are partially or completely surrounded by the persistent egg shell.

The head is almost hemispherical and slightly sclerotised; it is 0.054 mm. long and 0.08 mm. wide. The mandibles (fig. 18A) are arched and light in colour about 0.013 mm. long each. The lateral longitudinal tracheal trunks extend along the sides of the body from the first thoracic to the eleventh body segment. Anteriorly, each trunk gives off a pair of short branches to the head. The two trunks are connected by two transverse commissures, a dorsal commissure on the prothorax and a ventral commissure on the tenth body segment. This instar and the succeeding four are metapneustic. Each

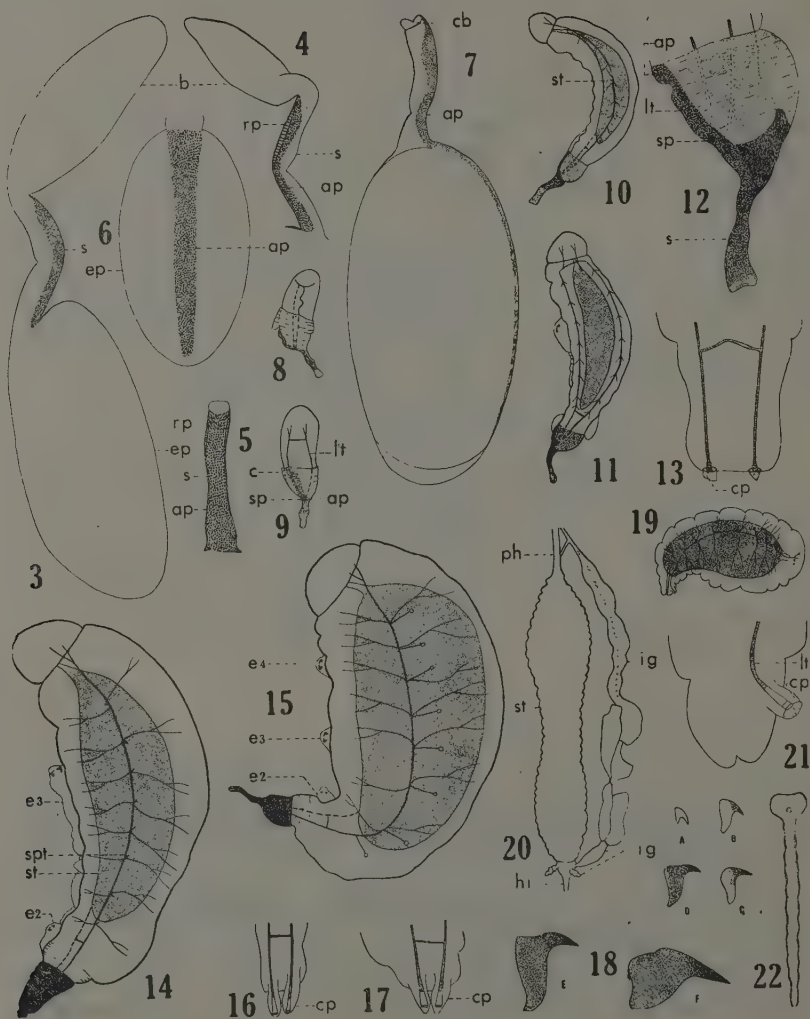


Fig. 3 : Ovarian egg (b, bulb; ep, egg proper; s, stalk). — Fig. 4 : Same, showing bulb and stalk (ap, aeroscopic plate; b, bulb; rp, respiratory plug; s, stalk). — Fig. 5 : Stalk, ventral view (ap, aeroscopic plate; rp, respiratory plug; s, stalk). — Fig. 6 : Egg proper (ap, aeroscopic plate). — Fig. 7 : Deposited egg (ap, aeroscopic plate; cb, collapsed bulb). — Fig. 8 : First instar larva, lateral view. — Fig. 9 : Same, ventral view (ap, aeroscopic plate; c, egg chorion; lt, lateral tracheal trunk; sp, spiracle). — Fig. 10 : Second instar larva (st, stomach). — Fig. 11 : Third instar larva. — Fig. 12 : Caudal end, second instar larva (ap,

aeroscopic plate; *lt*, lateral tracheal trunk; *s*, stalk; *sp*, spiracle). — Fig. 13 : Caudal end (freed), third instar larva (*cp*, caudal process). — Fig. 14 : Fourth larval instar (*e2* and *e3*, exuviae of second and third larval instars; *spt*, spiracular branch; *st*, stomach). — Fig. 15 : Fifth larval instar (*e2*, *e3* and *e4*, exuviae of second, third, and fourth larval instars). — Fig. 16 : Caudal end of fourth larval instar (*cp*, caudal process). — Fig. 17 : Caudal end of fifth larval instar (*cp*, caudal process). — Fig. 18 : A, B, C, D, E, and F, mandibles of first, second, third, fourth, fifth, and sixth larval instars. — Fig. 19 : Sixth larval instar. — Fig. 20 : Alimentary system of same (*hi*, hind gut; *ig*, ileac gland; *lg*, labial or salivary gland; *ph*, pharynx; *st*, stomach). — Fig. 21 : Caudal end of same (*cp*, caudal process; *lt*, lateral tracheal trunk). — Fig. 22 : Central nervous system of same.

lateral trunk ends posteriorly in a spiracle which is attached to the egg shell at the center of the aeroscopic plate near the stalk.

At the end of this instar the larva attains a length of about 0.29 mm. and a breadth of about 0.01 mm.

At ecdysis of this instar and the succeeding four the exuvium is sloughed off to the posterior extremity of the body and remains attached to the egg shell.

Second instar larva

This instar (fig. 10) is 0.44 mm. long and 0.12 mm. wide. The head is rounded and almost as long as broad being 0.08 mm. long and 0.096 mm. wide. The mandibles (fig. 18 B) are arched and broad at the base about 0.018 mm. long each; and except for their distal ends which are pigmented, the mandibles are light in colour.

The respiratory system is more developed than in the preceding instar, along its course, each lateral trunk gives off eight pairs of tracheal branches which are arranged on the mesothorax, the metathorax and the first six abdominal segments.

At this stage the aeroscopic plate and the chorion turn black. Melanization of the plate commences on the proximal part of the stalk, and that of the chorion on that part nearer to the stalk (fig. 12).

Third instar larva

This instar (fig. 11) is 0.72 mm. long and 0.112 mm. wide. The head is 0.014 mm. in length and 0.112 mm. in width. The mandibles (fig. 18 C) are 0.022 mm. long and 0.028 mm. wide at the base each. The posterior spiracles are attached to the aeroscopic plate at approximately the same position as in the previous instar; each is enclosed by a cup shaped thin walled process which arises from the posterior extremity of the eleventh body segment (fig. 13).

Fourth instar larva

This instar (fig. 14) is 0.96 mm. long and 0.24 mm. wide; the head is 0.096 mm. in length and 0.16 mm. in breadth; the mandibles (fig. 18 D)

are completely pigmented and about 0.027 mm. long and 0.036 mm. wide at the base each. Each lateral tracheal trunk gives off eight stub-like spiracular branches which arise from or near the points of connection of the tracheal branches with the main trunks. The exuviae of the preceding instars now push off the egg chorion a little distance. But the posterior spiracles are still in contact with the aeroscopic plate at approximately the same position as in the previous instars. This is brought about by the elongation of the caudal spiracular branches and the spear shaped thin walled caudal processes which enclose them and carry the spiracles at their distal ends (fig. 16).

Fifth instar larva

This instar (fig. 15) is 2.08 mm. long and 0.65 mm. wide; the head is 0.16 mm. long and 0.21 mm. wide; and the mandibles (fig. 18E) are 0.048 mm. long each. The meso- and metathoracic spiracles as well as the spiracles of the first six abdominal segments are now completely developed and are functional at least at the end of this stage. The posterior spiracles are carried at the distal ends of two caudal processes (fig. 17) and are still in contact with the aeroscopic plate, though not as firmly attached as in the previous instars.

Sixth instar larva

This instar (fig. 19) is almost twice as long as broad and tapers very distinctly to the posterior end. It is 2.34 mm. long and 1.30 mm. wide. The head is no longer visible on the dorsal surface. It comes to lie on the ventral surface of the prothorax. It is 0.24 mm. wide and 0.12 mm. long. The mandibles (fig. 18F) are 0.072 mm. long and 0.032 mm. wide each.

The egg chorion and the exuviae of the previous instars which so far have persisted around the posterior extremity of the body are now cast off and the caudal end of the larva becomes free. The caudal processes are shortened and slightly directed anteriorly; they carry the posterior spiracles at their distal ends (fig. 21).

The digestive system of the full grown larva (fig. 20) is of interest. The mouth is situated on the ventral surface of the head, it leads to a narrow tubular pharynx. The latter dilates posteriorly into a wide blind sac, the stomach, whose walls form a series of folds which increase its surface area. At its posterior end, the stomach is not continuous with the hind gut. The latter organ is a simple tube which is differentiated into a funnel shaped proximal region and a tubular distal region. At the connection of the stomach with the hind gut there are two tubular structures which are not much unlike the malpighian tubes. In addition, there are two other structures which are connected anteriorly with the salivary glands. These structures,

the ileac glands, open at the connection of the stomach with the hind gut; their secretions together with those of the salivary glands form the amber yellow or dark brown cocoon which encloses the full grown larva.

The nervous system (fig. 22) consists of two spherical cerebroidal ganglia situated in the head dorsal to the alimentary canal and of a ventral nerve cord with eleven incompletely differentiated ganglia, a ganglion for each body segment. Each ganglion gives off a pair of nerves to its corresponding segment.

Prepupa and pupa

As with *Anagyrus aegyptiacus* Moursi the prepupa and pupa lie enclosed within the cocoon inside the host ventral side downward and with the head at the posterior end of the host. The anterior end of the host is marked with dark brown or black because of the stomach contents of the full grown larva which are discharged at this region during the change to the prepupa.

BIOLOGY

Emergence, mating, superparasitism and multiple parasitism have been discussed under *Anagyrus aegyptiacus* Moursi.

Sex ratio

From 549 insects collected in the field on 20.9.1946, 288 were males and 261 were females. The sex ratio being 1:1. The same ratio is obtained when the insect is reared in the laboratory.

Longevity

The longevity of adults varies with the season; generally females live longer than males. Three males and six females emerging on 12.12.1945 died after 5, 5, 60, 19, 33, 58, 60, 70, and 78 days respectively. Two males and three females emerging on 19.1.1946 died after 29, 38, 47, 62, and 71 days respectively.

Life cycle

The life cycle varies with temperature and with the stage of the host attacked. At a temperature of 27°C. the cycle takes 20 days when 20 days old hosts are used and 30 days when 10 days old hosts are used. In the last case the first larval instar is obviously prolonged, but embryonic development is unaffected. Male and female hosts are attacked, but adult parasites vary in size as to the sex of their hosts. Adults bred in male hosts are smaller in size than those bred in female hosts.

Host specificity

All insects used in this study were either collected in the field or bred in the laboratory. In both cases the parasites were reared on the Lebbek

Mealybug (*Pseudococcus filamentosus* Ckll.). The author has failed to collect the parasite on the Hibiscus Mealybug (*Phenacoccus hirsutus* Green), from the field. Furthermore, attempts to rear the parasite on this pest in the laboratory have not only failed, but the parasite even refrained from ovipositing. The parasite was reported, however, to emerge in abundance from the Hibiscus Mealybug. The above observations and experiments would seem to indicate that this pest is at least not a regular host of the parasite.

Overwintering and seasonal abundance

Follow in the main the same trend as illustrated previously in *Anagyrus aegyptiacus* Moursi.

SUMMARY

Leptomastix phenacocci is an important parasite of the Lebbek Mealybug (*Pseudococcus filamentosus*). Field observations and laboratory experiments seem to indicate that it is at least not a normal parasite of *Phenacoccus hirsutus*. There are six larval instars; the first is surrounded by the trophamnion. The caudal ends of the first five instars are enclosed by the egg chorion and by the persistent exuviae of the preceding instars. The caudal ends of the third, fourth, fifth and sixth larval instars are provided with a pair of caudal processes each which carry the posterior spiracles at their distal ends. Life cycle, superparasitism, multiple parasitism, sex ratio, mating, oviposition, emergence, overwintering and seasonal abundance are similar to those of *Anagyrus aegyptiacus* Moursi.

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A Note on *Blastodacna libanotica* Dkff.

[Lepidoptera : Cosmopterigidae]

(with 6 Text-Figures)

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Early in 1938, Prof. H. Najjar, an agronomist at the American University of Beirut, gave me two peculiar galls out of four which he had collected from pear twigs in Abaydieh (altitude 600 m.). A few days later, three moths emerged from the four galls. One specimen was sent to Dr. Martin Hering in Berlin for determination. He wrote back that the species is new and that it belonged to the genus *Blastodacna*. He also suggested sending it to Dr. A. Diakonoff in Amsterdam who was reviewing the systematics of the same genus. Diakonoff described it in *Tijdschrift voor Entomologie*, Deel 82, 1939, and gave figures of the male genitalia.

I was able to secure but one immature caterpillar in August 1941, probably a third instar larva. This is due to the fact that :

(a) the galls at the beginning are not conspicuous, being very small in size;

(b) the foliage hides them;

(c) the difficulty of locating the galls during the growing season, due to their situation on the current year's growth, usually way up on thickly foliated trees.

However when the leaves fall in autumn, the galls become more or less conspicuous and by that time the insect will be in the pupal stage.

The moths emerge in February and March, during the very early hours of the morning, and by six o'clock a.m. their wings are dry, and they are ready to fly. The males appear about three or four days earlier than the females as a rule, but in March, 1941, I found a pair « in copula » while there were no moths in the cage in the previous day. After four days twelve shrunken eggs, light brown in color, were found scattered in the same glass rearing-cage; these never hatched. The incubation period could

not be determined, but it should be less than a week since the eggs are not sheltered by the buds, as proved by the entrance of the caterpillars at the internodes. If they were sheltered by the buds, there is no reason why they should wander exposed to bore into the wood to seek shelter again.

The newly born larva starts boring upward ⁽¹⁾ at an angle of about 30° until about the center of the gall is reached, since by that time the lower gall is already formed. Then it changes the angle abruptly to about 80° until it reaches a point right in line with the epidermal layer of the normal twig, if that line were extended into the gall. The larva then changes the angle again to about 30°. By that time the larva is probably in the third instar, and the date is the first week in August. Now the caterpillar turns down and starts enlarging the tunnel to accomodate its

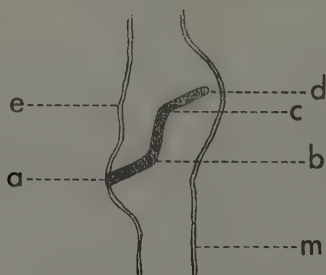


Fig. 1 : Longitudinal section through a gall produced by *Blastodacna libanotica* Dkff. ($\times 4$).

growing body. When the end of the journey is reached, the caterpillar enlarges the diameter of the opening, renders it circular, and polishes it for about 0.5 mm. around the entrance. Prior to that time the opening is well concealed which may have protected the larva from parasites.

Frost (1942) says : « It is often difficult to determine where boring ends and gall making begins ». This insect is a very good illustration whereby both operations take place simultaneously and at their best.

The gall is a regular swelling. It is composed of a lower chamber, where an entrance to a tunnel is situated, and an upper chamber which is identical to the lower one in shape and size, except that it is turned 180° on its vertical axis (fig. 1).

The gall grows as the insect grows. The direction of the proliferation of cells in the twig is always opposite the head of the caterpillar ; the nearer the tunnel is to the cambium the greater is the bulge (fig. 1). Early in

(1) In all cases the larval burrows showed the negative geotropism of the caterpillars.

the journey there will be no bulge at « a »; but a slight one opposite « b ». It is comparatively slight because the tunnel is away from the cambium at that point. As the tunnel develops towards the meristematic cells « m », these are induced to multiply and so bulge out until the maximum is reached facing the point « d ». It thus appears that the caterpillar starts feeding on the ceiling of the tunnel with its mouth pointing upward, and its back downward, as proved by the later bulging at « e » which was not present in the immature gall on August 3rd, 1941, but was found in eleven other galls where moths or their parasites ⁽²⁾ had emerged. The big bulge at « a » is the equivalent of the one at « d » except that it is very slightly larger, since the practically intact cambium is barely touched before it is destroyed. If the cause of the proliferation of cells is enzymatic secretion (Frost, 1942), then the enzyme in this case is secreted somewhere at the anterior end of the caterpillar, and has greater penetrability towards the cambium layer facing the head.

Parasitism

The gall described above is the normal one, and is typical for all non-parasitized specimens. On one occasion (March 3rd, 1942) four galls were collected from a dwarfed Hawthorn tree; one of them looked normal, while the others were misshaped in different degrees. Upon opening the two most abnormal ones, two pupae were found with smooth faced anterior ends that looked like those of Hymenoptera. Between the 13th and the 18th of March, four wasps emerged, one from each gall ⁽³⁾. The pupae were not enclosed in any larval or pupal skin of the caterpillar; it therefore may be that the wasp is an external parasite of the larva.

The Abnormal Gall

It was observed that the gall containing the parasitized larvae were either smooth on one side (fig. 3), or ovoid (fig. 4). The smooth galls show where and when the caterpillar had ceased to produce the enzyme necessary for the proliferation of the cells as a consequence of the attack of the parasitic larva. The ovoid gall may have been produced by an annoyed caterpillar, that tried to get rid of the Ichneumonid caterpillar by describing an oval path.

Though the formation of the gall is the result of the proliferation of cells induced by the boring habit, this insect should be classed as a gall producer since the gall is much more conspicuous than the short thin tunnel,

⁽²⁾ Another exception will be mentioned under « Parasitism » below.

⁽³⁾ These were classified as Pimplinae (Ichneumonidae), at the Imperial Institute of Entomology in London. It was not possible to determine them further because the greater part of the British Museum Collections were still evacuated in the country then.

and the twigs do not break at the tunnel, because the loss of xylem elements is compensated by the proliferation of the cells of the cortex.

If the most important gain derived by an insect from the boring habit is protection, then this insect is in great need of it as proved by its scarcity and extent of parasitism. For example the shortness of the tunnel is a great

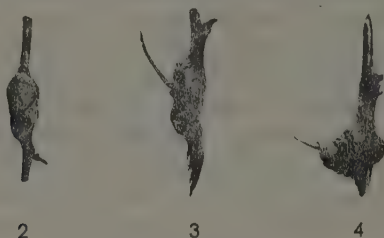


Fig. 2 : Normal gall. — Fig. 3: Parasitized gall (smooth). — Fig. 4: Parasitized gall (ovoid) [Photo A. Artinian, Staff Photographer at the American University, Beirut].

disadvantage, since the caterpillar can be easily reached by medium sized ovipositors of Hymenopterous parasites.

In three galls the pupae cases of the moths were found lying on their backs on the floor of the tunnels; this was probably the result of the moths trying to extricate themselves from the pupal cases. In no instance was the pupal case found partially protruding from the opening after the emerging

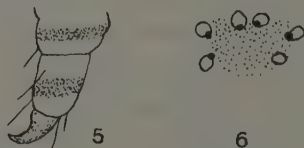


Fig. 5 : Thoracic legs. — Fig. 6 : The ocelli of the head.

of the moths, as occurs with the Leopard Moth (*Zeuzera pyrina* L.), nor was any grass ever found inside the tunnels.

The Larva

The larva is dirty white in color, measures 7 mm. in this stage, and naked. The thoracic legs have two dark bands around them, and a few setae (fig. 5). The whole body is highly undulated and glossy. The false legs are born on the 3rd, 4th, 5th, 6th, and last segments of the abdomen. The crochets are uniordinal. The general shape of the larva reminds one of the

larvae of Chrysomelid beetles in that they are plump in the middle and more or less tapering at both ends.

The epicranial suture is darker than the sclerites composing the cranium. There are three pairs of ocelli on each side of the head arranged as seen in figure 6. No further description of the larva was possible.

Before the discovery of this species, the genus *Blastodacna* was known to contain only the borers *B. atra* Hw. and its var. *putripenella* Zell., *B. vinolentella* H.-S., and the Hawthorn Berry Feeder *B. hellerella* Dup. (Diakonoff, 1939). This species, *B. libanotica* Dkff., adds to the list a very interesting combination of a gall producer, and a borer at the same time.

I must express my thanks to Mr. E.P. Wiltshire for his helpful suggestions and for reading the typescript.

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RESULTS OF THE ARMSTRONG COLLEGE EXPEDITION
TO SIWA OASIS (LIBYAN DESERT), 1935

Report on the Relationship between
Predator and Prey

by J. OMER-COOPER

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This problem forced itself upon our notice as we collected the fauna. The very high proportion of predators in some environments has puzzled me on several previous occasions. As a rule, one can get over the difficulty by supposing it to be a fortuitous result of immigration. At Siwa any such hypothesis is inadmissible. The problem was brought to my notice there by the Aphids and their enemies; as it had been at Wicken Fen by the Dytiscidae. At Wicken Fen, as was pointed out by Omer-Cooper and Tottenham 1932, pp. 497-498, the preponderance of carnivores was the expression of different metabolic levels and the types of carnivora present were dependent upon the level of metabolism induced by the physico-chemical nature of the environment. For example, in poorly oxygenated waters, or in waters where food was scarce, the rate of reproduction and growth in the food organisms was slow and the predominant carnivorous types were slow growing, whereas where oxygen and food were abundant, and the growth rate of the food organisms was, in consequence, high, carnivora which had a high rate of growth abounded.

Aphids are attacked by a number of predators which depend upon these rapidly reproducing organisms for their nutrition. Such predators are usually specialized for their diet. They do not eat other organisms. Thus we get a closed system of predator and prey which lends itself to mathematical treatment.

In England one is struck by the enormous numbers of Aphids. These insects seem to be everywhere and to cover almost every plant and tree. The predators are not very noticeable. In general collecting one catches thousands of Aphids, a fair number of Coccinelids, a few Lacewings and only very

rarely does one notice a Coniopterygid. There are, of course, the Syrphids which are plentiful and, in autumn, sometimes appear in very great numbers, but, during the greater part of the year, Aphids are a serious pest and their predators are not conspicuous by their abundance.

At Siwa Aphids were not abundant. They were to be found on the Berseem (*Medicago sativa* L.) and on several other plants but were absent from the fruit trees. Compared with English cultivated lands the gardens of Siwa were surprisingly free from Aphids. Nowhere did their numbers warrant their description as a pest. Coccinelids were not very numerous, although they were not scarce, but Lacewings were abundant and Coniopterygids were collected in some numbers. Throughout the greater part of our stay in Siwa *Chrysopa* spec. was a conspicuously abundant insect. As the Syrphid population was small a considerable population of Chrysopidae is not surprising and the abundance of these insects would have caused us no surprise had they appeared in the autumn only, or had Aphids been numerous at some time during the year. As it was, the abundance of the predators and the scarcity of the prey was astonishing.

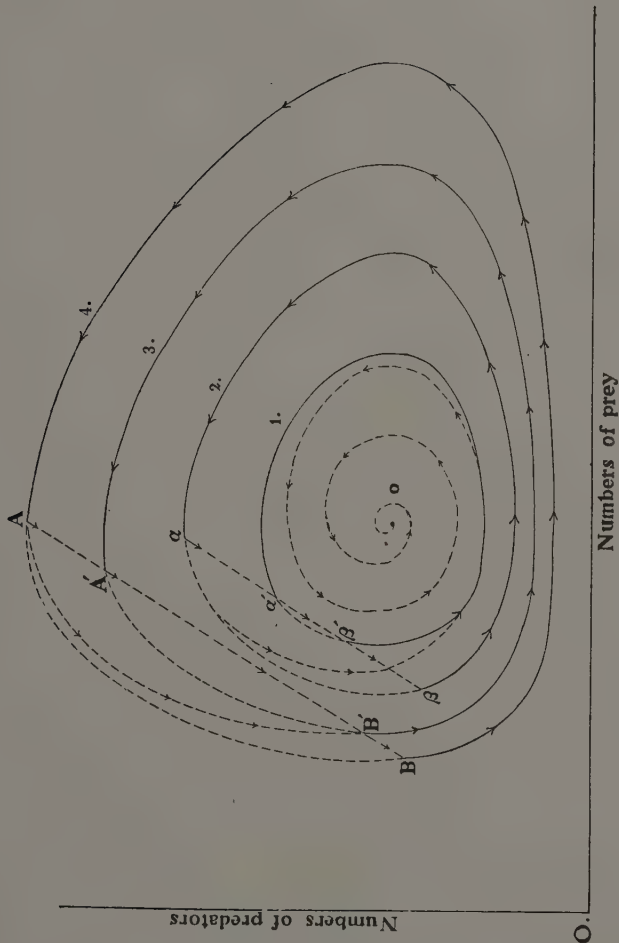
The explanation appears to us to be, in part, due to the disparity in metabolic rates between the two organisms. Aphids are notable for their high rate of growth and reproduction, whereas most Neuroptera are slow in their metabolic processes and capable of fasting for considerable periods. Under such circumstances, if the aphids were controlled by the *Chrysopa*, as we judged to be the case, the small number of the prey and the large number of the predators would not be remarkable.

The control of an organism of high metabolic rate by one of slow metabolism is unusual. In ponds, and presumably elsewhere, such a condition would be associated with some environmental factor which made the food organism scarce. At Siwa, food for the aphids, in the form of Berseem, was very plentiful; and, although in places the low humidity may have been harmful, amongst the well irrigated berseem beds a micro-climate would, very generally, be present, admirably suited to their rapid growth and multiplication. Their failure to become numerous was due to the presence of the large numbers of *Chrysopa*, etc.. A vicious circle had arisen in which a fast reproducing organism was controlled to such an extent by its predators that predators of slow metabolism predominated. This is a state of affairs quite outside my previous experience and one which greatly intrigued me.

This explanation appears to be one of considerable interest as it has a wide application. If one examines the beautiful graph evolved by Lotka 1925 (p. 90, fig. 13), and by Volterra 1928, Chapman 1931 (p. 419, fig. 3) one sees that the result of the severe English winter, which produces a great destruction of Aphids, will be to increase the fluctuations of both

The Relationship between Predator and Prey

J. Omer-Cooper



Text-Fig. 1. — Graph showing the relationship of predator and prey in a closed system.

(After Volterra, modified)

the predator and the prey. As these fluctuations would tend to be damped out (see Lotka 1925, pp. 90-92, fig. 14, Volterra Case 2 sub case C [Chapman 1931, p. 448]) after a series of mild winters during which the destruction of the aphids would be less than normal their numbers would become more stable and, while they would never become very scarce, they would never appear in very great numbers. This I have indicated in a diagram slightly modified from that of Volterra (Text-Fig. 1) by the cycle No. 3. After a severe winter, if the period of the cycle was not unduly prolonged (as it would be if the number of aphids fell too low), the cycle No. 4 would be set up and aphids would prove a serious pest during early summer, while, in late autumn there would be an outburst of predators. In such a cycle as this the predators of high metabolic rate would have the advantage and, in consequence, in such years we should expect to find Syrphids particularly abundant, whereas the slow recovery of the Chrysopidae would not have permitted their numbers to have reached anything approaching the maximum by the time that the winter again cut off both predator and prey.

At Siwa the winters are not severe. There may be cold days but the average temperature in January, the coldest month, is 19.4°C. and, although there is occasional frost at night, there is not that cold wet weather which is so destructive to insect life. Furthermore the food plants do not disappear during any part of the year. A certain destruction of insect life does take place, so that a cycle is inaugurated, but this will, under normal conditions, approach the cycle No. 1 and, even in extreme cases, will not be likely to exceed cycle No. 2. Under such conditions where there is a strong tendency to approach a condition of stability, in which the predator so completely controls the prey that no fluctuations occur (indicated in the figure by the point 0), aphids will never become a pest and, owing to their scarcity and to the high carry over of predators from one cycle to the next, the predator of high metabolic rate will suffer under a severe handicap; its place will, consequently, be taken by forms capable of enduring starvation or of subsisting on a low diet.

A corollary to this is that no animal will become a severe pest, in its natural habitat, unless it is sensitive to the environment and is, in consequence, periodically greatly depleted in numbers. This is, we believe, a theoretical conclusion amply justified by our knowledge of insect pests: they do fluctuate greatly in numbers.

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The Longevity of the Bean Weevil: *Acanthoscelides obsoletus* Say

[Coleoptera : Bruchidae]

(with 8 Tables)

by Dr. HUSSEIN ZAAZOU,
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INTRODUCTION

The most important enemy of the culture of beans all over the world is the common bean weevil (*Acanthoscelides obsoletus* Say). Wherever common varieties of beans (*Phaseolus vulgaris*) and lima bean (*Phaseolus lunatus*) are grown, losses usually result from the injuries to the seeds by the bean weevil. Climatic conditions favourable to the production of beans are ideal for the development of the bean weevil.

In the United States the economic importance of this weevil has been noted in several state agricultural experimental stations' bulletins and circulars, in agricultural journals, in trade journals and in several publications of the United States Department of Agriculture.

The following passage which is quoted from Larson and Fisher (1938) illustrates the economic importance of the bean weevil: « The injury to the bean may not be noted at harvest time, but it is usually noticed after the crop has been stored in the warehouse or after it has reached its destination if shipped. Growers often store beans in what appears to them to be perfect conditions, only to find later that they have been partly or completely ruined ».

The large-scale grower and the wholesale dealer often sustain heavy losses from the weevils, but they usually say little for fear publication might prevent or hinder the sale of their products. Probably the loss for the whole country must mount into millions of pounds. Kieffer (1929) said that weevils cost the bean growers in the three regions San Joaquin, Stanislaus and Merced between 1.000.000 and 1.250.000 pounds on their 1926 crop.

Owing to its great economic importance and the great variety of seeds it attacks, the biology of the bean weevil received attention from an early date. The first economic account of it was published in 1861 by Fitch as reported by Larson (1938). Chittenden (1898) also studied its biology. Since that date several writers (Manter, 1912; Headlee, 1917; Canter, 1925; Zacher, 1929; Menusan, 1935; Herford, 1935; and Ralph, 1940) have studied different phases of its biology.

In spite of the many workers who have studied the biology of the bean weevil, to this day several phases of its life history remain obscure. There has been very little study, particularly none on the adult stage by which alone any new infestation can be established.

Before controlling an insect it is important to know how long the adult stage live under different conditions. Longevity may be taken as a measure of the speed of the adult metabolism under different conditions of temperature, humidity, etc..

Bodenheimer in his work « Animal Ecology (1924) » distinguishes between two different kinds of longevity :

(a) Physiological longevity which may be defined as that duration which a healthy individual may expect to live under optimal environmental conditions until dying by senescence.

(b) Ecological longevity which is the average longevity of an individual of a population living under natural conditions. It is affected by many environmental factors.

So in this paper, while discussing the effect of some ecological factors on the longevity of the bean weevil, it is of course, the ecological longevity which is studied.

The effect of temperature and humidity acting on both the adult and on the larval stages and of mating on the longevity of the bean weevil is outlined in this paper. The effect of food and population density on the longevity is also discussed.

MATERIAL AND TECHNIQUE

The original material for these experiments was obtained from the insectary of the Biological Field Station, Slough. All breedings were started by putting about 50 adults in one pound glass jar, half filled with beans (normally red kidney beans). The mouths of the jars were covered with muslin secured round the neck by rubber bands. The jars except when otherwise stated were kept in an insectary where the mean temperature was about 24°C.

To obtain newly emerged weevils, a jar in which the new generation was just coming out was selected and the weevils removed at 6 p.m.. Next

morning, at about 10 a.m., all the weevils which were found in the jars were taken. These weevils which were about 16 hours old, were considered to be newly emerged. They could not have laid any eggs, as the pre-ovipositional period at 25° C. is not less than 48 hours.

To condition the food to the different experimental conditions, the beans were put in a thin layer in a cardboard trays 10 × 6 cm., six or seven of these trays were put one on top of the other in deep containers maintained at the appropriate relative humidity with KOH solution. The containers were kept in the laboratory (temperature 18° C to 24° C) and the specific gravity of the KOH solution was checked every two weeks. The water content of the beans was determined on 10 grs. dried at 104° C for 24 hours. It was found that eight weeks were needed for the red kidney beans to reach equilibrium at laboratory conditions.

For controlling humidity, desiccators with well-fitting and slightly greased lids were used. At the bottom of each desiccator was put about 150 cc. of an appropriate solution of potassium hydroxide (determined by specific gravity). According to Norris (1934), it may be taken that, where weevils are stated to have been kept in a certain humidity, they are really at that humidity for at least twenty three out of twenty four hours, and this is allowing a generous margin for error. To ensure that the atmosphere inside the dessiccator reached the specific humidity for the experiments, the KOH solution was put in the desiccators 24 hours before it was used. The solution was checked and brought back to its original specific gravity after every week.

For the different temperatures, the constant temperature rooms of the field station and several electric incubators were used.

(1) THE EFFECT OF COMBINED TEMPERATURE AND HUMIDITY ACTING ON THE ADULT STAGE ON THE LONGEVITY

The fact that within the favourable range of temperature the individual life of an insect becomes longer at lower temperature is well known. Uvarov (1926) gave a good summary of the data in « *Insect and Climate* ».

Few attempts have been made to study the phenomenon in a systematic way. Baumberger (1914) reached the conclusion that the increase in the length of the adult life is approximately proportional to the temperature. Norther (1917) found that the increase in the longevity is of the same order as that required by « Van't Hof's » rule for the chemical reactions.

To study the effect of both temperature and humidity on the longevity of the bean weevil systematically a series of experiments were conducted at five different temperatures and six humidities. The temperatures used were 15° C, 18° C, 21° C, 25° C, and 31° C. One male and one female of

newly emerged weevils which were reared on red kidney beans were put in 2×1 " specimen tube containing two conditioned red kidney beans. The tubes were put in desiccators containing KOH solution giving the humidity wanted. The different humidities used were 30, 55, 65, 75, 90, and 100 % R.H. Weevils were sexed as soon as they died and the death dates of every male and female were separately recorded. The results of all these experiments are given in Table I.

The figures given in the Table are the average longevity and the standard deviation of groups of 20 weevils.

The first point to be observed is the difference between the sexes in the mean duration of life. In all conditions females lived longer than males. This difference varied with the temperature at which the adult lived, at a lower temperature 15°C and 75 % relative humidity, the difference in the longevity was about 3.4 days, while at 25°C and the same relative humidity the difference was 1.9 days, at 31°C the difference was one day only. But in all cases, the difference is about 10 % of the length of life. Headlee (1919) working with the bean weevil, did not distinguish between the longevity of the two sexes, but studied the longevity of generations kept in jars, not individual weevils. This might account for the very high longevity he obtained which was about 30 days at 25°C . Later on in this paper, it will be seen that density has some effect on the mean longevity. Increasing the number of weevils kept together in a closed space, increased their mean longevity.

The well established fact that the longevity of the insect decreases as the temperature is increased can be seen in Table I. The effect was observed at all the different humidities used.

To find out whether the decrease in the longevity with the rise in temperature is of the same order as that required by « Van't Hof's » rule for the chemical reaction (the length of life nearly doubled by a reduction of ten degrees in the temperature) the figures for 90 % relative humidity which is the favourable humidity have been chosen. Table II shows the different longevities of both sexes at different temperatures and 90 % relative humidity.

Table II shows that the longevity of both sexes nearly doubled by a reduction of 10 degrees in temperature. The Q_{10} or the coefficient expressing the rate of increase was not constant but varied according to the temperature limits discussed. At a lower limit (15°C) it was relatively greater than at the upper limit 31°C .

The explanation of this temperature effect upon the duration of life which has been most in favour is that of Northrop (1917). He concluded that : The observation on the temperature coefficient for the duration of

TABLE I
Effect of combined Temperature and Humidity on the Longevity of the Bean Weevil

TEMPERATURE IN °C		PERCENTAGE OF RELATIVE HUMIDITY									
30		55		65		75		90		100	
LONGEVITY AND STANDARD DEVIATION		LONGEVITY AND STANDARD DEVIATION		LONGEVITY AND STANDARD DEVIATION		LONGEVITY AND STANDARD DEVIATION		LONGEVITY AND STANDARD DEVIATION		LONGEVITY AND STANDARD DEVIATION	
Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
15	32.1 ± 4.0	34.8 ± 4.6	33.1 ± 5.8	35.2 ± 4.9	33.0 ± 3.6	36.1 ± 3.5	33.3 ± 3.3	36.7 ± 3.7	33.9 ± 4.1	31.2 ± 3.8	—
18	26.6 ± 2.3	29.5 ± 2.1	26.6 ± 1.4	29.7 ± 1.7	26.9 ± 1.9	30.0 ± 2.0	27.1 ± 2.1	29.1 ± 2.5	27.5 ± 2.1	30.2 ± 2.4	—
21	15.5 ± 1.5	16.9 ± 1.8	16.3 ± 1.7	17.8 ± 2.1	17.1 ± 1.6	18.4 ± 1.1	17.0 ± 1.0	19.1 ± 2.1	19.1 ± 2.1	21.5 ± 3.0	16.2 ± 1.7
25	10.7 ± 1.1	13.2 ± 1.4	12.2 ± 1.4	14.5 ± 1.7	12.4 ± 1.7	14.2 ± 1.1	13.8 ± 1.6	15.7 ± 1.7	12.7 ± 1.1	14.6 ± 1.4	11.7 ± 1.6
31	9.9 ± 1.8	10.7 ± 1.3	9.5 ± 1.5	10.5 ± 1.6	9.5 ± 1.6	10.6 ± 1.2	9.5 ± 1.6	10.5 ± 1.3	9.5 ± 1.3	10.2 ± 1.6	—

TABLE II

TEMPERATURE IN °C	MALE LONGEVITY IN DAYS	Q 10	FEMALE LONGEVITY IN DAYS	Q 10
15	33.9	2.40	37.2	2.30
18	27.5	—	30.2	—
21	19.3	2.02	21.5	1.90
25	13.8	—	15.7	—
31	9.5	—	10.9	—

life suggests that this duration is determined by the production of a substance leading to old age and natural death and temperature controls the rate of production of these hypothetical chemical substances ».

An alternative explanation is biological in its essence rather than chemical. It is a simple fact of observation that the total activity of an insect is greater at higher temperature than at lower temperature. Weevils which were kept at a low temperature were not as active in their movements as those kept at a higher temperature. Wheeler (1929) is of the opinion that in the inverse relation between the rate of living and the duration of life is probably to be found the physiological basis for the lengthening of the adult life in social insects. He points out that all the sub-social and social insects, live in environments which restrict muscular movement, dark, poor in oxygen and of rather low temperature. All these conditions would favour a lowered rate of metabolism and activity.

The reason why the bean weevil has a shorter duration of imaginal life at higher temperature may be simply because it is more active at those temperatures, it has a higher rate of living and consequently a shorter duration of life.

(II) THE EFFECT OF RELATIVE HUMIDITY

The effect of atmospheric humidity on the development of different stages of insects has often been investigated and it is usually found that atmospheric humidity has some effect on every stage of an insect. This effect is most to be expected among insects dependent upon metabolic water during their development.

The adult stage of the bean weevil living in warehouses depends entirely on metabolic water. Atmospheric humidity ought to have great effect on its longevity.

Table I gives the results of the effect of six different relative humidities at five different temperatures. It shows that atmospheric humidity had a

slight effect on the longevity of the bean weevil, though as the relative humidity was increased the mean duration of life was also increased. This increase in the duration of life varies according to the temperature used. At low temperature (15 and 18° C) the increase in relative humidity causes a very slight increase in the longevity, an increase never exceeding 3.7 % in either sex.

At a moderate temperature (21-25° C) the increase in the longevity due to the increase in the relative humidity was more pronounced. The maximum increase in longevity was 12.6 % for the females and 11.7 % for the males. The total increase in the longevity which resulted by 60 % increase in the relative humidity at 25° C was about 25 % for the females. This shows that the effect of relative humidity was much more pronounced when it acted at a moderate temperature (21-25° C) than when it acted at a low temperature.

At high temperature (31°), relative humidity did not have any effect on the longevity of the bean weevil as it is shown in Table I.

In conclusion, atmospheric humidity has a slight effect on the longevity of the bean weevil. The longevity increases as the relative humidity increases to 90 % R. H., but at 100 % R. H. there is a decrease in the longevity. The effect of the relative humidity differs according to the temperature. At low temperature the effect is very small and about constant between 30 and 90 % R. H., while at medium temperature (21-25° C) the effect is great and depends on the part of the humidity range studied. At high temperature (31° C) the relative humidity does not effect the longevity of the bean weevil.

(III) THE EFFECT OF TEMPERATURE AND HUMIDITY ACTING DURING THE DEVELOPMENTAL STAGES ON THE LONGEVITY OF THE ADULT

Apparently very few attempts have been made to show the effect of temperature and humidity acting upon the developmental stages of the insect on the longevity of the subsequent adults. Lund (1938) found that the longevity of *Trichogramma evanescens* was reduced as the temperature at which the parasites were reared to maturity was lowered. Alpatov (1932) obtained different results with *Drosophila melanogaster*. He found that the longevity of both males and females was increased as the temperature at which they were reared to maturity was lowered.

As the bean weevil does not feed on solid food during its adult life and as its longevity depends on the energy which has been accumulated during the developmental period, it will be of considerable practical importance to find out how temperature and humidity acting upon the immature stages will effect the longevity of the resultant adults.

A series of experiments were conducted as follows :

The hosts for rearing the bean weevil were three lots of red kidney beans exposed to 55, 65, and 75 % R. H. for several weeks, till they reached equilibrium. In each of eighteen petri-dishes which were divided into three lots of six dishes, was placed a single layer of red kidney beans. Six dishes were filled with beans conditioned at 55 % R. H., another six with those from 65 %, and the last six with those from 75 % R. H.. In each of three desiccators which contained a potassium hydroxide solution giving 55 % R. H., were placed two petri-dishes containing beans conditioned at the same relative humidity (55 %). The same was done with desiccators containing a solution giving 65 and 75 % R. H. Altogether nine desiccators were used, three for each relative humidity. Over the layer of seeds in the petri-dishes were sprinkled about 40 newly emerged weevils of about 3-4 days old which were left to lay eggs for 24 hours. All the petri-dishes were covered with muslin secured by rubber bands. One desiccator of each R. H. was put at constant temperature of 25° C, one at 21° C and one at 30° C. After 24 hours the weevils were removed leaving the eggs in the dishes. The dishes were left in the desiccators without any disturbance apart from the changing of the potassium solution every fortnight, till the progeny came out. Weevils were sexed as soon as they emerged and one male and one female being put in 2×1" specimen tubes containing three conditioned red kidney beans (70 % R. H.) and covered with muslin. From every humidity temperature combination twenty tubes were made up. All the tubes were kept under observation at the standard conditions of 25° C and 70 % R. H. Thus the influence of different temperatures and humidities acting upon the immature stages was tested at constant conditions. The death dates for males and females were recorded and the results are given in Table III. These figures are the average longevity and standard deviation for 20 adults.

Table III shows that the humidity in which the weevils were reared to maturity had a slight effect upon the longevity of the subsequent adults. Humidity has the same general influence upon longevity when acts upon the developmental stages as when it acts upon the adults only (the longevity increased as the relative humidity was increased).

The effect of the relative humidity was much more pronounced when it was acting during the relatively long developmental period than when it acted on the short adult life.

(IV) TEMPERATURE

As far the effect of temperature, Table III shows that weevils reared at 25° C had the lowest longevity, any increase or decrease over or below

that temperature caused an increase in the longevity of the resultant adults.

These results do not agree with those of Alpatov (1932) in *Drosophila melanogaster*; he found that the longevity increased as the temperature at which they were reared to maturity was lowered.

Raichoudhury and Jacobs (1931) found that the adults of *Ephestia kuhniella* which were reared at 30° C lived longer than those which were reared at 23° C when both were kept at 30° C. These results are not far from those obtained here.

TABLE III

*Effect of combined Temperature and Humidity
acting on the immature stages
on the Longevity of the Bean Weevil*

TEMPERATURE IN °C	PERCENTAGE OF RELATIVE HUMIDITY					
	55		65		75	
	70		70		70	
	LONGEVITY AND STANDARD DEVIATION		LONGEVITY AND STANDARD DEVIATION		LONGEVITY AND STANDARD DEVIATION	
	Males	Females	Males	Females	Males	Females
30					No emergence	
25	14.8 ± 1.1	20.5 ± 2.8	15.4 ± 1.6	20.2 ± .9		
25						
25	13.8 ± 1.2	14.8 ± .5	14.2 ± 1.4	16.3 ± 1.7	14.9 ± 1.1	17.6 ± 2.1
21						
25	14.3 ± 1.1	17.8 ± 2.2	17.1 ± 1.7	19.5 ± 2.3	15.7 ± 1.6	18.3 ± 1.8
Temperature and humidity of development above line and of life below line.						

These results indicate with a considerable degree of probability that the quantitative effects of temperature differences upon the biological processes concerned in growth are not the same as the quantitative effects of temperature differences upon the biological processes concerned in the determination of the duration of the imaginal life. High temperature (30° C) acting upon the adults reduced longevity but when it acted upon the immature stages, it increased longevity. High temperature acting upon the immature stages, might accelerate the development of some parts, while the development of the other parts might not be affected. The adult bean weevil which was reared at high temperature, might have emerged when

it was not fully matured or developed. Subsequently it might take some time during the imaginal stage to complete its development, and this might lead to greater longevity.

This is only a suggestion, more investigation of this effect is needed before drawing any conclusion. During the present work it was found out that the adults of the bean weevil usually remain for a few days inside the beans after the last moult. This period differs according to the temperature at which the cultures were kept, high temperature accelerated the emergence of the adults, while those which were kept at lower temperature remained for a longer period inside the beans. This might also explain the greater longevity of the weevils reared at high temperature. The few days which were usually spent inside the beans if the weevils were reared at a lower temperature were spent outside and included in the longevity of the adults. So this greater longevity may be due to both the different effect of the high temperature on the development of different parts and the reduction or the elimination of the period spent inside the beans after the last moult.

The increase in the longevity of the weevils which were reared at low temperature (21° C) might be due to the increase in size and weight of the weevils. This increase in size of the weevils reared at low temperature, which was noticed by Menusan (1936) may be due to the accumulation of more energy (fat body) during the longer development period.

This extra energy might enable the adults to live longer.

(V) THE EFFECT OF MATING ON LONGEVITY

To investigate the effect of mating on the longevity of the bean weevil, two sets of experiments were conducted at 70 % R. H. and 25° C temperature. The longevities of 120 weevils which were taken from the same culture were recorded (40 unmated males, 40 unmated females, and 40 mated males and females).

To obtain unmated weevils, beans containing fully grown adults which were about to emerge were selected and separated singly in 2×1" specimen tube. All the tubes (each tube contains only one bean) were kept in the laboratory under constant observation. As soon as any weevil came out, it was transferred to a new specimen tube containing two conditioned red kidney beans. It did not take more than seven hours to obtain a sufficient number of unmated weevils. All the weevils were kept in the C. T. room (25° C temp., 70 % R. H.) and examined daily.

The longevity of every weevil was recorded. The results are shown in Table IV.

Table IV shows that the unmated weevils of both sexes lived longer than mated ones. This shorter longevity might be due to the loss of energy

TABLE IV

UNMATED WEEVILS		MATED WEEVILS	
MALE LONGEVITY IN DAYS	FEMALE LONGEVITY IN DAYS	MALE LONGEVITY IN DAYS	FEMALE LONGEVITY IN DAYS
13.4 \pm 2.1	16.2 \pm 2.4	13.2 \pm 1.7	14.7 \pm 2.7

spent in the mating process, in finding the other sex, and in egg laying. So in the case of the unmated weevils the energy which would have been lost, if mating was allowed, caused this increase in longevity.

(VI) THE EFFECT OF FOOD AND POPULATION DENSITY ON THE LONGEVITY

(1) Food during the adult stage

It is remarkable how writers have refrained from definite statements on the feeding habits of the adult bean weevil (*Acanthoscelides obsoletus* Say). The general assumption is that no food is required, and as soon as the energy stored up by the larva is exhausted the adult dies.

Zacher (1929) states that *A. obsoletus*, were able to mate and oviposit without feeding as adults. The Bruchids carrying sufficient food in the form of a large fat-body from the larval stage through the pupal stage to enable them to reach maturity without taking further food. He added : « Although feeding in the adult stage is not essential to reproduction, it may nevertheless occur ».

Kunhikannan (quoted by Larson, 1940) in speaking of *Callosobruchus chinensis* L. which he says is typical of all other Bruchids says : « Weevils were bred in successive generations, the adults taking neither food nor drink throughout their existence without apparent injury to them or effect upon their activities ». He says further : « That they feed cannot be stated definitely, none was observed to do so, although it is quite possible that they may feed sometimes on green pods and foliage of the host plant ».

It can be gathered from these scattered statements that the bean weevil might feed on flower nectar or might drink water.

How far will this affect its longevity ?

Several writers stated that carbohydrates can serve as an exclusive food for adult insects. Uvarov gave a good summary of the work on carbohydrate foods.

The following passage is quoted from page 311 of « Insect nutrition and metabolism » :

« Glaser (1923) in his experiments with adult house flies, found that sugar or some sort of starch which can be assimilated is an important factor in the longevity of the flies. In Vinokurov's (1922) experiments with the same insect, adult flies were able to live on a diet of pure sugar for 11.9 to 19.4 days although without food they died within very few days. Similarly, adult beetles, *Bruchus quadrimaculatus* F. lived longer on sugar water than without any food, or when receiving only pure water (Larson and Fisher, 1929) ».

Fraenkel (1940) showed that the adult blow-fly (*Calliphora erythrocephala*) when deprived of water, and all nutrient, lived for about 2.5 days while those given water alone lived for 3.5 days. But flies which received some carbohydrates lived for 18.35 days.

The longevity of *A. obsoletus* in the warehouse where it does not get any food is about two weeks, but conditions are favourable for reproduction during this short time of its life.

This is not the case in the field. There is a long period every summer during which there is no suitable place for oviposition (ripen beans), but crops become infested later. This would indicate one of two things :

(a) The infestation is caused by weevils which have emerged during the summer, just before the crop is sufficiently matured for oviposition to take place.

(b) The adult weevil consumes some kind of nourishment which prolongs its life.

Experiments and observations indicate that in the great majority of instances the first case is true, the second case may offer a solution for a very light infestation in some cases and forms the basis for experiments here in described. These experiments were conducted to determine whether or not the presence of certain foods will aid the adult weevils to live longer than they ordinarily live under normal warehouse conditions. Whether the adult weevils live three months or less than a fortnight is a vital question when trying to control them in the field.

In the following experiments 80 pairs of weevils of about 16 hours old which have been reared on red kidney beans were used. They were sexed and a pair placed in a 2×1" specimen tube containing three conditioned red kidney beans. In each of the first 20 tubes a drop of water was put, the second twenty each received a drop of honey, to the third twenty, a drop of saturated water sugar solution was added. The remaining 20 tubes which contained only red kidney beans were used as a control. All these tubes were kept at 25°C and 70 % R. H.. Water, sugar solution and honey were replenished as needed. Because of evaporation, the water needed to be replenished daily honey and sugar less frequently. The longevity of both males and females were recorded. The results are shown in Table V.

It can be seen from that Table, that there was not a striking difference in the longevity of weevils given water and those receiving nothing. The difference of about 2 days while significant is useless in relation to control measures. Taking the maximum length of life, a difference was observed especially in the longevity of the females which showed an increase of nearly 35 per cent. This increase is quite significant and must be taken into consideration.

TABLE V

*Effect of water, sugar solution, and honey
on the Longevity of the Bean Weevil*

LONGEVITY IN DAYS OF WEEVILS GIVEN WATER		LONGEVITY IN DAYS OF WEEVILS GIVEN HONEY		LONGEVITY IN DAYS OF WEEVILS GIVEN SUGAR SOLUTION		LONGEVITY IN DAYS OF WEEVILS GIVEN NOTHING (CONTROL)	
Males	Females	Males	Females	Males	Females	Males	Females
14.2 \pm 1.1	16.3 \pm 2.5	59 \pm 11.4	62 \pm 14.3	58.9 \pm 12.2	63.4 \pm 13.6	12.7 \pm 0.9	14.5 \pm 1.4
Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum
16	23	81	89	74	85	14	17

The possibility had however, to be considered that the small difference in the average longevity had been brought about by raising the atmospheric humidity inside the tubes containing the drop of water, not by actual drinking of water. In order to eliminate the humidity factor it was necessary to carry out experiments in which the weevils given water were kept at the same humidity as those which were given no water. So, instead of putting a drop of water every day, a piece of wet blotting paper was put in each tube for a period of an hour at the end of which the paper was removed and the weevils were transferred to clean dry tubes. The results obtained were as follows :

Male longevity : 14.5 \pm 1.2 days ; female longevity : 16.2 \pm 1.8 days.

Comparing these figures with those mentioned before, no striking difference can be seen. Whether a drop of water is put in the tube or a piece of wet blotting paper is left in it for an hour, the weevils had the same longevity. So the slight increase in longevity was due to the actual drinking of water, not to the raised atmospheric humidity.

In conclusion, it can be said, that drinking water has a very slight effect on the average longevity of the bean weevil, but a higher increase (about 35 %) was noticed in the maximum longevity of female weevils.

An examination of Table V shows that there was a great difference between the average length of life of the weevils receiving sugar solution

and honey and that of those receiving none. Males receiving honey lived nearly four times as long as the control.

Considering the maximum length of life, the difference was greater. Males fed on honey had a maximum longevity of 81 days and that of the females was 89 days.

Weevils fed on sugar had nearly the same longevity as those fed on honey, males and females averaging for 58.9 days and 63.4 days.

It became clear now that weevils living in warehouses usually die prematurely, their longevity never exceeding 14 days. But weevils living in the field and causing the slight infestation to the new crop usually have a very long life. In the field they can feed on nectar, and support themselves for as long as two months.

Measures for field control suggested by Larson and Fisher (1925) were based on the assumption that the adult weevils live only for 14 days. They stated that the amount of infestation at the harvest was proportional to the number of weevils that have been liberated within flying distance of the field during the time the bean has been ripening. If during this time weevils were prevented from flying to the field the crop will be uninfested at the harvest. They presumed from their investigation that weevils reaching the field before the beans were nearly ripe, would have died before finding mature beans for oviposition. But this is not the case for it has been shown here that the adult weevil can feed on nectar and prolong its life far as long as two months. This time will be more than enough for the unripe bean to ripen and to receive the eggs of the weevils.

Will the weevils continue to lay fertile eggs throughout their life? This question will be discussed in another paper.

(2) Food during the larval stages

It has been stated before that the longevity of the adult weevil living in warehouses, where no soluble food is available, is determined by their inborn energy. This energy is accumulated during the development of the larval stages. Once this energy is consumed death will come in. G. M. Herford (1935) stated that the larvae of *A. obsoletus* attack great varieties of seed, it is probable that all the *Phascolus* species can be attacked, and also several in the neighbouring genera. She also showed in the same paper that the chemical composition of the seeds had a great effect on the activity of *A. obsoletus*. It will be of some interest to find out whether weevils reared on seeds which differ in their chemical composition have the same longevity.

Seven different kinds of seeds which had been exposed to 70 % R. H. and 25° C temperature for eight weeks, till they reached equilibrium, were selected. They were : red kidney beans, white kidney beans, black V. beans, pea beans, lima beans, haricot beans, and garden peas.

In each of seven petri-dishes 10.0×1.5 cm. was placed a single layer of each of the different seeds. Over this layer of seeds were sprinkled 100 eggs of about 16 hours old, from weevils reared on red kidney beans. All the dishes were treated in the same way, and kept in the C. T. room (25°C , 70.8 % R. H.) after being covered with muslin. Careful observation was maintained till the new weevils emerged.

Twenty pairs of the newly emerged weevils of about 16 hours old were taken from each culture. One male and one female were put together in a 2×1 " specimen tube with 3 conditioned red kidney beans. Red kidney beans were provided in all cases, irrespective of the host from which the weevils were derived. All the tubes after being covered with muslin were kept at 25°C and 70 % R. H.. The longevity of each weevil was recorded. The results are shown in Table VI.

TABLE VI
*Effect of Food during the larval stages
on the Longevity of the Bean Weevil*

LARVAL FOOD	MALE LONGEVITY IN DAYS	FEMALE LONGEVITY IN DAYS
White kidney beans	12.9 ± 1.6	15.2 ± 2.4
Red kidney beans	12.7 ± 1.3	14.7 ± 1.7
Black V beans	12.7 ± 1.2	14.7 ± 1.6
Pea beans	13.0 ± 1.4	14.9 ± 2.1
Lima beans	12.1 ± 1.5	13.7 ± 1.8
Peas	9.7 ± 2.1	14.7 ± 1.9
Haricot beans	15.0 ± 1.6	18.8 ± 2.7

Weevils reared on different kinds of hosts had different longevitys, as indicated in the above Table. Apart from the weevils reared on haricot beans which had the highest longevity, the difference between the different longevitys was not pronounced. This difference was never more than one day except in the male longevity of weevils reared on peas.

(3) The effect of Population Density on Longevity

It has long been known that the degree of crowding of organisms in a given space, or the density of the population, has an influence upon various vital processes of the individuals composing the population. In the matter of growth Semper, and before him Jabez Hogg (cited from Lund) showed that the volume of water apart from food and other conditions has an influence upon the rate.

Far (1861-1870) showed that there is in man a definite relation between density of population and the death rate.

Elton (1924) stated in his work « Animal Ecology » that the optimum density for longevity among animals was not always the minimum.

Pearl and Parker (1922) found that the rate of reproduction of *Drosophila* during the first 16 days of its imaginal life varies inversely with the density of the population.

TABLE VII
*Effect of Population Density
on the Longevity of the Bean Weevil*

NUMBER OF WEEVILS KEPT TOGETHER	LONGEVITY IN DAYS						
	FIRST WEEVIL	SECOND WEEVIL	THIRD WEEVIL	FOURTH WEEVIL	FIFTH WEEVIL	SIXTH WEEVIL	SEVENTH WEEVIL
Unmated males							
1	14.3	—	—	—	—	—	—
2	13.7	17.2	—	—	—	—	—
3	12.6	15.4	19.6	—	—	—	—
4	11.5	13.4	14.5	20.1	—	—	—
5	11.2	14.2	16.5	17.5	22.7	—	—
6	10.9	11.5	16.1	19.6	21.3	26.8	—
7	10.5	13.0	15.9	17.9	18.9	20.9	25.1
Unmated Females							
1	16.2	—	—	—	—	—	—
2	15.2	19.2	—	—	—	—	—
3	14.2	17.6	21.6	—	—	—	—
4	13.7	18.7	21.5	26.0	—	—	—
5	16.3	19.4	21.5	24.6	29.9	—	—
6	13.2	17.2	20.9	22.6	26.5	32.0	—
7	12.8	17.0	19.5	21.3	23.1	25.3	29.5
Each of these results is the average longevity for ten weevils.							

To investigate further the influence of population density on the longevity of *A. obsoletus*, twelve series of experiments, half of which dealt with unmated females, and the other half with unmated males were started. Each series consisted of ten 2 x 1" specimen tubes, each of which contained 2 conditioned red kidney beans. All conditions were the same for all the tubes, the only significant variable between the several series was the den-

sity of population. Unmated weevils which were sexed as soon as they emerged, were obtained by the method mentioned previously. Two unmated males were put in each of the first 10 tubes (the first series), the second ten tubes each of which received three unmated males, the third series each received four unmated males, and so on till the number of the unmated weevils in each tube of the last series was seven. The rest of the experiments which dealt with the unmated females were arranged in the same manner. All the tubes after being covered with muslin secured with rubber bands were kept at 25° C and 70 % R.H.. The weevils were examined daily and the dates of emergence and death were recorded. Dead weevils were removed as soon as they died.

The results are shown in Table VII, and each of these results is the average longevity for ten weevils.

To facilitate comparison between the longevitys of different densities Table VIII is made. It gives the average longevitys of the first and the last weevil to die, and also the average longevity of all the weevils.

TABLE VIII

MALES				FEMALES			
NUMBER OF WEEVIL IN TUBES	AVERAGE LONGEVITY IN DAYS OF FIRST WEEVIL TO DIE	AVERAGE LONGEVITY IN DAYS OF LAST WEEVIL TO DIE	AVERAGE LONGEVITY IN DAYS OF ALL WEEVILS TO DIE	NUMBER OF WEEVIL IN TUBES	AVERAGE LONGEVITY IN DAYS OF FIRST WEEVIL TO DIE	AVERAGE LONGEVITY IN DAYS OF LAST WEEVIL TO DIE	AVERAGE LONGEVITY IN DAYS OF ALL WEEVILS TO DIE
1	14.3	14.3	14.3	1	16.2	16.2	16.2
2	13.7	17.2	15.4	2	15.2	19.2	17.2
3	12.6	19.6	15.9	3	14.2	21.6	17.8
4	11.5	20.1	14.9	4	13.7	26.0	19.9
5	11.2	22.7	16.4	5	16.3	29.9	22.3
6	10.9	26.8	18.2	6	13.2	32.0	22.1
7	10.5	25.1	17.4	7	12.8	29.5	21.2

It is apparent from this Table that the longevity of the adult is much affected by density. In the case of the unmated males, the Table shows a decrease in the longevity of the first weevil to die as the density of population increased. This decrease continued up to a density of seven weevils per tube. With the unmated females the same results were obtained. A decrease occurred in the longevity of the first weevil to die, as the number of unmated females which were kept together was increased.

As for the longevity of the last weevil to die, the Table shows that it

increased both in males and females as the number of weevils kept together was increased. This increase in longevity went on till the number of weevils kept together was six where the longevity reached its maximum. The increase to seven caused a decrease in the longevity.

As for the average longevities of all the weevils kept together the figures indicate that there was an increase in the average longevity as the number of weevils kept together increased, till the number reached a certain density which might be called the optimum density for longevity, any increase in the number of weevils after that optimum caused a decrease in the average longevity. In the case of the unmated males the optimum density for longevity was reached when the number of weevils kept together was six.

The same effect was noticed among the unmated females, the longevity increased as the number of females kept together was increased, till the optimum density for longevity was reached. This was five or six unmated females kept together. The experiments with five unmated females seems anomalous and requires repetition, but unfortunately the culture from which the weevils had been taken was attacked by mites and destroyed. So the optimum density for maximum longevity might be considered as six weevils.

It is not yet possible to provide an explanation of these results but it is hoped to carry out further work on the problem later.

Pear and Parker (1924) obtained similar results working with *Drosophila melanogaster*. They found that the mean duration of life increased as the number of the flies kept together in one ounce bottle was increased. After a density of 55 flies per bottle was passed the mean duration of life declined steadily with advancing density.

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The optimum lethal dose of pyrethrum for the Control of Mosquitoes (Culicinae) in determination of lethal dose against *Anopheles gambiae*

(with 2 Tables)

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INTRODUCTION

During the Anti-gambiae Campaign in Upper Egypt an enquiry in the efficiency of pyrethrum spray insecticide and the optimum lethal dose for *A. gambiae* was raised.

Investigations were carried out in 1944 at the Gambiae Eradication Laboratory in Assiut to determine the lethal dose of the insecticide used in routine house flitting.

Observations on adult mosquitoes after house flitting were made over a long period by unnotified examination and by collection of adult mosquitoes by floor searching directly after the disinsectization Squad had left the house. The insects were then put in small muslin cages and left in the laboratory until the next morning when they were examined and the number of recovered insects was recorded. It was concluded that out of each hundred adult Culicinae twenty one recovered and remained normally alive for the next few days.

As the ultimate aim of the campaign was the eradication of *A. gambiae*, it was most necessary to perfect each of the control measure steps so as to give a 100 % kill. Thus, it was important to find out the factors contributing to low mortality. These were many and some of them were rather difficult to measure.

The major factor was the dosage of pyrethrum spray insecticide per unit volume because it was noticed, on several occasions, that the Mulahezeen did not deliver enough amount of the spray to cover the entire space evenly.

Furthermore, the residents did not follow the instructions to keep windows and doors closed for the specified period.

In order to find out the amount of the insecticide actually used in house flitting, the volume of ten houses as well as the used quantity of pyrethrum spray were estimated. It was found that the spray was used at the rate of about 0.5 cc. per 100 cubic feet. It was, therefore, decided to test the efficacy of 0.5 cc. pyrethrum spray insecticide per 100 cubic feet, as well as the lethal amount necessary for a 100 per cent kill under controlled conditions.

Material and Technique

For this purpose, a circular¹ tent with a conical top made of army duck was erected in the yard of the Gambiae Eradication Service. Its volume was approximately 882 cubic feet and had, near the top, two circular screened openings covered with muslin to admit light when needed and were closed during the test period.

The material used here consisted entirely of same age adult female of *Culicinae* engorged with human blood. To eliminate variations in the resistance of the mosquitoes to the toxic pyrethrins, adults were reared in the laboratory from egg clusters secured from a nearby well. Each batch of eggs was put in a large pan half full with water from the same well. It contained a natural food supply of algae which maintained the developing larvae in normal condition. The pans were placed in a cool, rather illuminated situation away from direct sunlight. As soon as the eggs in each batch hatched, the larvae were taken by a pipette and separated in small groups in several pans to prevent overcrowding and to provide the larvae with fresh supplies of food and water. It was difficult to keep crowded larvae well nourished on the amount of nutriment already present in the water. Again, the pupae were transferred into pans covered with muslin. Immediately after emergence, the adults were freed in a large mosquito net (namosiah) where they were fed overnight on human blood from naked arms and legs of a volunteer. It was easy, on account of the engorged abdomen of the females, to sort them out in the next morning before each test. All males were destroyed.

Two trials, each with four repetitions were conducted; the first with 0.5 cc. pyrethrum spray per 100 cubic feet i.e. the same amount used in routine work, and the second with double this amount i.e. at the rate of 1 cc. per 100 cubic feet.

The spray insecticide was taken from pyrethrum stock concentrate used in house flitting and was freshly prepared before each test to the required strength i.e. 0.07 % by Dr. Lutfy of the Gambiae Service.

In each test a hundred female mosquitoes were liberated in the tent, a

variable number was kept in captivity inside one or two small cages fixed opposite each other alongside the walls of the tent and a hundred left outside in a control cage.

Before each test, the tent was thoroughly aerated and tested for any biological effect of pyrethrins that may have been left over from previous tests. This was done by liberating a few mosquitoes inside the tent and leaving them for half an hour. These insects were unaffected and the tent was considered free from traces of the insecticide which might interfere with the results of subsequent tests. Ordinary small hand sprayers for house flitting were used in these tests.

Soon after the fixing of the mosquito-containing cages on the walls of the tent and the settlement of the free mosquitoes on the tent walls, the writer, standing in the middle of the tent with the sprayer held with a more or less stretched arm at head level, delivered the spray quickly and evenly in all directions. The last drop of spray was discharged by blowing the sprayers turned upside down. The behaviour of caged mosquitoes was closely watched during and after the operation. Free insects were collected as soon as they dropped on the tent floor which was covered with white paper sheets. Three collections were made in each test; the first for mosquitoes dropping during the first five minutes, the second for those dropping during the second five minutes and the third for the rest of the remaining insects. Each of these lots was put in a separate labelled cage and kept together with the caged mosquitoes and the control in the laboratory for percentage recovery.

Discussion

It may be seen from Table I that the percentage kill of adult Culicinae had gone up to 83.2 for free mosquitoes instead of 79.0 in the routine work. It is also slightly higher in the caged mosquitoes being 84.1. Presumably, this higher mortality inside the tent may be explained by the even distribution of the insecticide and the closing of the tent for a period not less than ten minutes.

A striking difference between trials I and II is noticeable in that 100 % of the insects were affected in the latter, while in the former an average of 6.8 % of the free and caged mosquitoes remained unaffected. This, however, will indicate that the 0.5 cc. per 100 cubic feet was a rather low sub-lethal dose.

It is apparent from Tables I and II that the largest number of the exposed insects were knocked down during the first five minutes. These were actually seen dropping while the insecticide was being atomized and seemed as if directly hit by the spray particles. Insects in captivity were

TABLE I
Kill results of repetitions of Trial I
(0.5 cc. per cubic foot)

NUMBER OF TEST	NUMBER OF INSECTS EXPOSED	NUMBER OF INSECTS KNOCKED DOWN			NUMBER OF INSECTS LIVING	NUMBER OF INSECTS RECOVERED	TOTAL NUMBER OF INSECTS DEAD
		First 5 minutes	Second 5 minutes	After ten minutes			
1	100 (free)	35	30	27	8	12	80
	20 (cage)	9	8	—	3	1	16
	100 (control)	—	—	—	100	—	—
2	100 (free)	45	25	21	9	10	81
	30 (cage)	15	10	4	1	3	26
	100 (control)	—	—	—	100	—	—
3	100 (free)	49	20	28	3	8	89
	12 (cage)	8	3	1	—	2	10
	100 (control)	—	—	—	100	—	—
4	100 (free)	35	26	30	9	8	83
	20 (cage)	10	4	6	—	3	17
	100 (control)	—	—	—	100	—	—
Total insects exposed..... 400 (free), 82 (cage) Total insects dead..... 333 (free), 69 (cage) Total insect control..... 400 Percentage average mortality 83.2 (free), 84.1 (cage) Nil (control)							

seen nervously jumping for the first few minutes and suddenly dropped down in the cages. In both trials, all the insects that recovered were from the third collection taken directly after ten minutes. The considered living insects in the sub-lethal dose were the unaffected as well as recovered mosquitoes before leaving the tent. The relatively lower kill percentage of caged mosquitoes in trial II was probably due to the intentional avoidance of directing the spray towards or near the cages.

TABLE II
Kill results of repetitions of Trial II
(1 cc. per 100 cubic feet)

NUMBER OF TEST	NUMBER OF INSECTS EXPOSED	NUMBER OF INSECTS KNOCKED DOWN			NUMBER OF INSECTS LIVING	NUMBER OF INSECTS RECOVERED	TOTAL NUMBER OF INSECTS DEAD
		First 5 minutes	Second 5 minutes	After ten minutes			
1	100 (free)	55	30	15	—	3	97
	25 (cage)	16	9	—	—	2	23
	100 (control)	—	—	—	100	—	—
2	100 (free)	42	36	22	—	4	96
	32 (cage)	20	12	—	—	3	29
	100 (control)	—	—	—	100	—	—
3	100 (free)	40	35	25	—	2	98
	50 (cage)	35	9	6	—	5	45
	100 (control)	—	—	—	100	—	—
4	100 (free)	46	22	32	—	3	97
	50 (cage)	34	16	—	—	—	50
	100 (control)	—	—	—	100	—	—
Total insects exposed.. 400 (free), 157 (cage)							
Total insects dead..... 388 (free), 147 (cage)							
Total insects control... 400							
% average mortality... 97.0 (free), 93.6 (cage)							
Nil (control)							

SUMMARY

(1) The actual amount of pyrethrum spray insecticide used in house flitting was determined and tested under controlled conditions.

(2) The dosage of the insecticide necessary for a satisfactory kill was found to be double the amount used in routine work i.e. 1 cc. per 100 cubic feet.

(3) Variations in individual susceptibility of the subjected adult mosquitoes were eliminated by raising the latter in the laboratory from eggs secured from a natural habitat. Adults of the same age fed on human blood overnight were used for the test next morning.

(4) The exposure period necessary for about 100 % kill with the lethal dose was found to be just over ten minutes.

(5) The lethal amount of the pyrethrum spray could be ascertained by a visible cloud of the insecticide uniformly distributed in the room. With a moderate speed, about a hundred seconds will be sufficient to deliver the right lethal dose of 0.07 % pyrethrum insecticide in a room of about one thousand cubic feet.

Acknowledgment

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2

Notes on Egyptian Tabanidae with comment on certain supraspecific categories of old World Tabanidae ⁽¹⁾

[Diptera]

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The genus *Tabanus* Linn. sensu lato has been a difficult one to define systematically by separation of generic and subgeneric groups and this has been attempted with varying success in the opinions of various present-day students of the Tabanidae. The most elaborate of the schemes — proposed by Enderlein in 1922 and 1924 — has been only partially accepted by subsequent workers.

Two of the most important and widely distributed of these groups comprise species differing from *Tabanus* sensu stricto in usually having hairy eyes, especially prominent in the males, and with or without ocelligerous tubercles on the vertex in the females. The majority of the component species are readily placed, but each group has certain intergrading species that make decisions difficult regarding the group separation on generic or only subgeneric levels. Moreover, the systematic terminology of both groups has been confused and present remarks give the author's views in this regard.

Atylotus Osten Sacken 1876

Mem. Boston Soc. Nat. Hist., 2: 425-426 (subgenus of *Tabanus*). Genotype *Tabanus bicolor* Wied. (the first of 4 listed species, the other 3 being *fulvescens* Walk. [equals *bicolor*], *fulvus* Meig. and *rusticus* Linn.), by designation of Coquillett, 1910.

Syn. *Dasystypia* Enderlein, 1922, *Mitt. Zool. Mus. Berlin*, 10: 347. Genotype *Tabanus rusticus* Linn., by original designation.

Syn. *Ochrops* Szilady, 1915, *Ent. Mitt.*, 4: 93. Genotype *Tabanus plebejus* Fallen, by designation of Enderlein, 1925.

Original characters: "Eyes pubescent, no vestige of an ocellar tubercle; frontal callosity wanting in the two American species (or small and rudimentary in the European spe-

(1) A Contribution from the Rocky Mountain Laboratory, Hamilton, Montana, Division of Infectious Diseases, National Institute of Health.

cies [and in a later described American species]); head rather large, very convex anteriorly, and rather concave posteriorly; difference in size between the large and small facets in the male considerable, line of division between them very distinct (even in dry specimens); palpi (♀) stout at base; upper branch of the third longitudinal vein [R_4] knee-shaped at base (emitting a stump of a vein in the European species); first posterior cell [cell R_5] broadly open, coloration of the eyes uniform (sometimes a single indistinct stripe)" [Osten Sacken].

Osten Sacken originally set this up in contrast to the subgenus *Theriopectes* Zeller, in consideration of the ocelligerous tubercles of most females of species included by Zeller which was subsequently properly emphasized by Osten Sacken.

Certain Palaearctic species with hairy eyes, no ocelligerous tubercle, but lacking the peculiar head-shape included by Osten Sacken — such as the *umbrinus* and *quatuornotatus* groups — have wrongly been assigned to *Atylotus* by some recent European students who assigned the real *Atylotus* species to *Ochrops*. This disregard of restrictive characters originally included by Osten Sacken, additional to the hairy eyes and lack of ocelligerous tubercles, also resulted in mistaken synonymy by Enderlein (1924) of *Brachytomus* Costa, 1857 (*Giamb. Vico Napoli*, 2:495; genotype *Tabanus gigas* Herbst as *T. ursus* nov. spec., designated by Coquillett, 1910, as *Brachytomus* [sic]), and by Kröber (1925) of *Theriopectes* Zeller, 1842 (*Isis von Oken* for 1842, p. 819; genotype *Tabanus tricolor* Zeller also by Coquillett). In his recent catalog, Kröber (1939) retained both *Ochrops* and the misinterpreted *Atylotus* as subgenera of *Tabanus*.

This interpretation was followed by Efflaton Bey (1930) for Egyptian Tabanidae, and by Shannon and Hadjinicolaou (1936) for those of Greece. In Egypt, therefore, the species previously included under *Ochrops*; namely, *egyptiacus* Kröb., *farinosus* Szil., *agrestis* Wied., *pulchellus* Lw., and *agricola* Wied. should be placed under *Atylotus*, while *alexandrinus* Wied. and *lunatus* Fabr. do not belong in that genus as discussed below.

Goffe (1931) correctly restricted the genus in his discussion of species in the British Isles, but he also accorded subgeneric status to *Dasystypia* Enderlein, which was originally proposed for *A. rusticus* Linné and related species with the spur vein ("recurrent veinlet") on R_4 . *A. agrestis* Wied. is an example among Egyptian species in *Atylotus* in which this spur may be long, short, absent, or even occasionally variable on the two sides of the same specimen. The other four Egyptian species of *Atylotus* above all possess the spur, but the use of *Dasystypia* for this group, even as a subgenus, is not warranted in our opinion. This spur is customarily absent in the genotype species of both *Atylotus* and its synonym *Ochrops* (*bicolor* and *plebejus* respectively), but is present in occasional specimens of each.

Of more concern systematically, is the variation in presence or apparent absence — and in amount — of pubescence on the eyes of species which obviously are otherwise related. When present, it is most pronounced in the male sex. *A. bicolor* and its Nearctic congeners all have plainly hairy eyes, but of the Egyptian species obviously generically related, only *A. agricola* has distinctly hairy eyes. In the other four species, the eyes are bare in both sexes, which appears more to warrant subgeneric evaluation than the spur-vein. Neither *Ochrops* nor *Dasystypia* are available names because of their hairy-eyed genotype, and *Surcoufiella* (syn. *Baikalia*), which Kröber (1939) synonymized with *Ochrops*, has different antennae as well as hairy eyes. *Abatylotus* subgen. nov., therefore, is proposed for this subgenus of *Atylotus* with *Tabanus agrestis* Wied. as subgenotype. Except for the ostensibly glabrous eyes ⁽²⁾, the characters of this subgenus are the same as those of *Atylotus*.

European students have not, as yet, recognized the value of the subepaulet (basicosta) as a supplemental, important systematic character in grouping the subfamily Tabaninae (see Philip 1941). Typical *Tabanus* species have black hairs on the subepaulet comparable to those on the adjoining coastal vein. In *Atylotus* species the hairs on the subepaulet are yellow.

In all the Pangoniinae known to the writer the subepaulets are flat, scale-like, and ostensibly bare, though microscopic tomentosity may be seen under high magnification. This is also true of certain elements in the Tabaninae, and is most elaborate in certain genera and even tribes, such as the Diachlorini or Dichelacerini, in the New World, Pacific, and Australian faunas. There are certain exceptional species with sparse hairs on the subepaulets, but the character appears to be of fundamental importance for differentiation of some tabanine groups.

In the Palearctic Region, *apricus*, *graecus*, *umbrinus*, *ater*, and *anthracina* are examples of species with bare subepaulets that will require special systematic attention, and « *Atylotus* » *alexandrinus* from Egypt and other Mediterranean areas is also one of these. Relationship with Neotropical *Stenotabanus* Lutz is indicated under the Tribe Diachlorini as revised by Fairchild (1942). *Tabanus alexandrinus* and *T. umbrinus* form a distinct element in this group which warrants generic recognition.

***Efflatounanus* gen. nov.**

Tabanus-like, medium-sized species with bare subepaulets, eyes in both sexes unbanded in life, sparsely hairy, no ocelligerous tubercles, antennae

⁽²⁾ Microscopic, very sparse, short hairs can be seen under high magnification on *A. agrestis* as on many other so-called "bare-eyed" species of tabanine flies.

with scapes and pedicels as in *Tabanus*, the plates of the third segments with no basal angles or teeth, and 4 apical annuli, labellae fleshy without sclerotized plates, palpi normal and rather slender, frons of females moderate in width, callosities peculiarly wrinkled and broad but separated from the eye margins, prolonged broadly toward the vertex.

Genotype *Tabanus alexandrinus* Wied.

The genotype and *T. umbrinus* Meig. both have predominately blackish, rather robust bodies, tinted wings without spur-veinlets, and hind-tibiae without the usual outer ciliate fringes. Hairs on the eyes of the latter are not as obvious as on *alexandrinus*.

The marked excision and acute basal tooth on the antennae of *T. anthracina* prevent its inclusion in the genus, though it has many other characters in common.

There is an anomalous group of flies with hairy eyes of varying density difficult to separate even subgenerically from *Tabanus* sensu str. because intermediate species occur which grade imperceptibly from distinct hairiness comparable to some *Hybomitra*, to the ostensibly bare eyes of acceptable *Tabanus* species which Stone discussed (1938) as basis for his reluctance to recognize these Nearctic elements as generically separable from *Tabanus*. Though *Hybomitra* (*Sziladynus* of authors) was recognized by Philip (1947) in the Nearctic catalog of species, there remained a residue of such anomalous species (*T. reinwardtii*, *T. sequax*, etc.) without ocelligerous tubercles which, for lack of a satisfactory dividing line, were left in *Tabanus*. It is this anomalous group which many European authors have placed unnaturally in *Atylotus* and *Theriopectes* and which includes the Egyptian *lunatus* and its variety *algericus* Thun. Since they cannot go into *Atylotus* and are not strictly congeneric with *Theriopectes tricolor* (which is peculiarly hairy even on the subcallus), it appears to us only to confuse the problem for reference and key purposes to remove them from *Tabanus* on present unsatisfactory grounds. For the present *lunatus* appears best returned to *Tabanus* sensu lato.

Hybomitra Enderlein, 1922

Mitt. Zool. Mus. Berlin, 10: 347 (nomen nudum); 1924, 11: 346. Genotype *Tabanus rhombicus* Osten Sacken, as *H. solox* nov. spec., by original designation.

Syn. *Theriopectes* of authors, not Zeller, 1842, *Isis von Oken*, p. 819.

Syn. *Therispectes* Marten, 1882, *Canad. Ent.* 14: 210 (lapsus).

Syn. *Poecilosoma* Lutz, 1909, *Inst. Oswaldo Cruz em Manguinhos*, p. 29. Not Hübner, 1816, and others. Lutz, 1911, *Int. Hyg. Ausst. Dresden*, p. 33; 1913, *Brasil-Med.*, 27(45): 6. Kröber, 1931, *Zool. Anz.*, 94: 69. Genotype *Tabanus quadripunctatus* Fabricius, desig. by Bequaert, 1924 (? for "*quadripunctatus* Macq." of Lutz).

? Syn. *Stypommia* Enderlein, 1922, Mitt. Zool. Mus. Berlin, 10: 346. Genotype *S. patagonica* Enderlein, original designation.

Syn. *Dasyommia* Enderlein, *ibid.*, p. 346. Genotype *Tabanus cinctus* Fabricius, orig. desig.

Syn. *Tylostypia* Enderlein, *ibid.*, p. 347. Genotype *Tabanus astur* Erichson, orig. desig.

Syn. *Dasyphyra* Enderlein, *ibid.*, p. 344. Genotype *Tabanus maculipennis* Macquart = *T. quadripunctatus* var. *amabilis* Walker, orig. desig.

Syn. *Hybopelma* Enderlein, *ibid.*, p. 351. Genotype *Tabanus quadripunctatus* Fabricius, orig. desig.

Syn. *Hypopelma* Enderlein, 1925, *ibid.*, 11: 355 (lapsus), 409 (corrected).

Syn. *Tylostypina* Enderlein, 1923, *Deut. Ent. Ztschr.*, p. 545. Genotype *Lepiselaga tartarica* Portsch., orig. desig.

Syn. *Sipala* Enderlein, 1923, *ibid.*, p. 545. Genotype *Therioplectes acuminator* Lw., orig. desig.

Syn. *Sziladynus* Enderlein, 1925, *Zool. Anz.*, 62: 181. Stone, 1938, *U.S.D.A. Misc. Publ. No. 305*, p. 37. Genotype *Tabanus aterrimus* Meigen, orig. desig.

Syn. *Poecilochlamys* Lutz, 1922, *Zool. Med.*, Sep. Folha Med., pp. 9 and 11; 1928, *Estud. Zool. Parasit. Venezol.*, p. 57. Genotype *Tabanus quadripunctatus* Fabricius, Genotype.

Syn. *Poeciloderas* Borgmeier 1933, *Rev. Ent.*, 3: 299. Lutz, 1921, *Bol. Inst. Oswaldo Cruz*, 1: 15 (nomen nudum). Kröber, 1932, *Rev. Ent.*, 2: 199; 1934, *Rev. Ent.*, 4: 297 (synonymy). Stone, 1938, *U.S.D.A. Misc. Publ. No. 305*, p. 37 (synonymy). Philip, 1941, *Canad. Ent.*, 73: 7. Genotype, *T. quadripunctatus* Fabricius, orig. desig.

Syn. *Aplocera* Enderlein, 1933, *Deut. Ent. Ztschr.*, p. 144. Genotype *Therioplectes caucasica* End., orig. desig.

Osten Sacken (1876) correctly evaluated the importance of the ocelligerous tubercle in the females in comparison with *Atylotus*, and Philip (1931) pointed out its application in the males of this group. The former, correctly at that time, applied the name *Therioplectes* Zeller, and was followed by many subsequent students of the *Tabanidae*. Due to the unfortunate selection by Coquillett (1910) of a non-representative and non-congeneric species as genotype from among Zeller's original series as recently reviewed by Goffe (1931), the name became no longer available for this important group of flies. Enderlein's elaborate system over-corrected this mistake creating what most workers now consider to be several synonyms for the same group of hairy-eyed flies. Action to clarify the confusion by the International Congress Rules Committee indicated as pending by Goffe has not occurred, and many recent students, including Kröber (1939) in his catalog of Palaearctic Tabanidae, have used *Sziladynus* End., 1925, though this name is antedated by several of Enderlein's other names (Philip, 1941). As presumed first reviewer under the Rules, Philip selected *Hybomitra* End., 1922, as most representative, without knowledge of Olsoufieff's (1937) previous adoption of *Tylostypia* End. for the Russian species.

As Stone and others have pointed out, the limits of the group are difficult to define because of variation in the combination of hairiness of

the eyes and distinctness of the ocelligerous tubercle. In two Nearctic species, *H. cincta* and *H. carolinensis*, the eyes of the females are without perceptible hairs though the tubercles are very distinct, and even bear ocelli in the first species (*Dasyommia* End.). On the other hand, occasional species, that otherwise appear congeneric, more with *Hybomitra* rather than with *Theriopectes* and have been placed in *Atylotus* of authors, lack the tubercle altogether, while the Neotropical *H. quadripunctatus* (subject of much taxonomic confusion) provides specimens with varying degrees to almost complete absence of ocelligerous tubercles. The great bulk of the species, however, are readily assigned in the group irrespective of the difficult ones, which gives the genus its taxonomic utility. Kröber (1939) also has given the group full generic status.

No species of the group have been recorded from Egypt though it seems but a question of time until one or more now known to occur in Mediterranean countries on both sides of Egypt will be taken also in that country.

To be added to the list of Egyptian species provided by Eflatoun (1930) are the following: *Tabanus lunatus* var. *algericus* Thun., *T. kingi* Aust., *T. terminalis* Walk., and *T. biguttatus* Wied. (vide Kröber 1939). The genus *Straba* End. to which the describer assigned the latter species based on enlarged facets in the male, has not been generally accepted as separable even subgenerically from *Tabanus*. The species listed previously as *T. intermedius* Egg., 1859, should be *T. eggeri* Schin., the first available synonym, since the former was a homonym of *T. intermedius* Walk., 1848, and cannot be revived under the Rules because of subsequent transfer of Walker's species to *Atylotus* as a synonym of *A. incisuralis* Walk.

SUMMARY

Comments and emendations are offered to the nomenclature of Egyptian Tabanidae since the monograph by Eflatoun (1930). The misinterpretation of *Atylotus* Osten Sacken by most European authors is pointed out, and a new subgenus *Abatylotus* is proposed for *Tabanus agrestis* Wied. (subgenotype) and its allies with bare eyes in both sexes. Also proposed is a new genus, *Eflatounanus*, for *Tabanus alexandrinus* Wied. (genotype) and *T. umbrinus* Meig. among the group with bare subepaulets. The application of *Hybomitra* End. to European species is discussed and synonymy indicated.

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12

The significance of the Genitalia in the Generic Determination of *Araeopidae* (Delphacidae)

[Hemiptera-Homoptera]

(with 15 Text-Figures)

by A.I. HASSAN, Ph.D. (London)

INTRODUCTION

The external male genitalia are considered at the present time as a very reliable specific character for identifying most groups of insects, particularly the species of the hemiptera-homoptera Araeopidae. They are constant for each species of this family, and their importance is noticed by different writers. Kirkaldy (1907, p. 150) stated : « the characters which appear to me to be of generic value in this section « *Liburnia* » lie in the genitalia and the tibial spur ». Again he suggested that : « the genitalia in the male are the final test of a species and even afford generic criteria ». There are still strong objections by some workers to base generic determination on any one constant character ; these preferring to accept a natural assemblage of characters from which to find the genus. But Fieber, Edwards, Muir, and China used the characters found in the pygofer, anal segment and genital styles for specific purposes, and also to separate the genera. Muir and Giffard (1924) stated : « We have based our specific work upon the male genitalia as experience has demonstrated that these are the most reliable characters to use in the family ». DeLong and Cartwright (1926) mentioned : « the only possible basis for distinguishing the species has been by means of external genitalia and characters such as the ventral segment of the female and the plates of the male ». Metcalf (1943) stated : « the male genitalia are the court of last appeal in specific determinations in this family ; and the known genera need revision ; with the characters of the male genitalia used to determine their bounds and

phylogenetic relationship ». This author changed the well known family name Delphacidae into Araeopidae, following the principle of Dr. Géza Horváth.

On examining the drawings done by China and others for the male genitalia of other homopterous insects, one can see that the members of one genus agree in the general plan; but on careful examination, one will find that they differ in the shape of the different organs.

No author before had paid any attention to the structure of the external genitalia of the female Araeopidae. On examining the external genitalia of the different females that I have got, I noticed many differences in the shape of the various organs. These differences are of a significant importance in the generic and specific determinations of Araeopidae, as it is the case with the external genitalia of the male.

GENERAL DESCRIPTION OF THE MALE GENITALIA

In the following description of the external male genitalia of the eight species of Araeopidae which I have studied, I will combine the nomenclatures of the different organs that were used by Giffard (1921, p. 135), Hem Sing-Pruthi (1925, p. 127), and Muir (1926, p. 337).

The pygofer is the ninth abdominal segment. It forms an armature around the male genitalia. It is either large and quite conspicuous, or small and narrow. In a dorsal view it is notched, and the notch may be triangular or circular. It is also produced backwards on each side of the anal segment forming two anal angles. These anal angles may be obtuse or acute; short or protruding posteriorly to a considerable distance in the conspicuous pygofer, and surrounding the anal and tenth segments to a greater extent. In a lateral view the pygofer either attains the same width, enlarges or narrows towards the sternal side. In an end view, it is rounded, triangular, or mostly oval in shape with the long axis either vertical or horizontal. The anal segment of Giffard is really the tenth abdominal segment. Sometimes it is large and conspicuous; in other cases it is smaller and hidden by the pygofer. The real anal segment is the eleventh and its appendage is the anal style. It is nearly conical, spindle, or disc-like in shape; short or long. The tenth segment has two anal processes at its sternal side; they are spiny; straight or curved inwards; adjacent or far away from each other. The intersegmental membrane between the ninth and tenth abdominal segments is known as the diaphragm. It is heavily or slightly chitinised. Its armature, the part supporting the aedeagus, is sometimes heavily chitinised and becomes conspicuous. The genital styles, or parameres, are chitinous rods with different shapes. They are either parallel to each other, or divergant from each other when seen in an end view.

Aedeagus is straight or curved. It is composed of an ejaculatory duct surrounded by a sheath, and passes through a large chitinous tube, the periandrum. The periandrum may carry large or small teeth, curved or straight, and directed towards the proximal end of the aedeagus. The periandrum has a membranous portion near its proximal end which is « the chamber » of Muir. The aedeagus is supported about its centre by a chitinous ring connected with the tenth segment and called the aedeagus basal support or strut, and at the proximal end by chitinous plates which are « the basal plates » of Sing-Pruthi. These plates have a chitinous bridge, with chitinous wings sometimes; and a prolongation attached to the parameres.

THE STRUCTURE OF THE EXTERNAL FEMALE GENITALIA

According to Verhoef (1893, p. 357) the ovipositor always consists of two pairs of valvulae; one from the eighth abdominal segment, and the other from the ninth segment. The first valvula possesses a canal through which the egg passes, when deposited, into the puncture which it does by its serrated dorsal surface. The second valvula forms a sheath around the first one. There are two pairs of chitinous sclerites attaching the two valvulae to the sternites. They are known as valvifers. The first valvifer attaches the first valvula to the eighth sternite, and the second attaches the second valvula to the ninth sternite (figs. 8 and 9).

COLLECTION AND PREPARATION OF MATERIAL FOR WORK

The material for this work was collected from Slough in England. On examining the collection of *Araeopidae* (Delphacidae) done in Egypt by Mr Alfieri, the General Secretary of Fouad 1st Entomological Society, I find that two unidentified species resemble very closely in their external features two species of my collection, which are *Stenocrenus minutus* (Fab.), and *Dicranotropis hamata* (Boh.); but I am not quite certain about their identity, as their genitalia are not fit for careful examination, and furthermore these two genera have not been found in Egypt to the present.

For preparation of specimens for this work, the posterior part of the abdomen of the male was separated, boiled in 20 % potassium hydroxide for ten minutes, washed in water, passed through alcohols up to absolute, then transferred to cedar-wood oil, xylol, then examined, described and drawn. The female genitalia was examined from the ventral surface of the abdomen directly.

Muir had described the male genitalia of *Criomorphus nigrolineata* (Scott), *Dicranotropis hamata* (Boh.) and *Delphacodes pellucida* (Fab.) so briefly that I prefer to describe them again here.

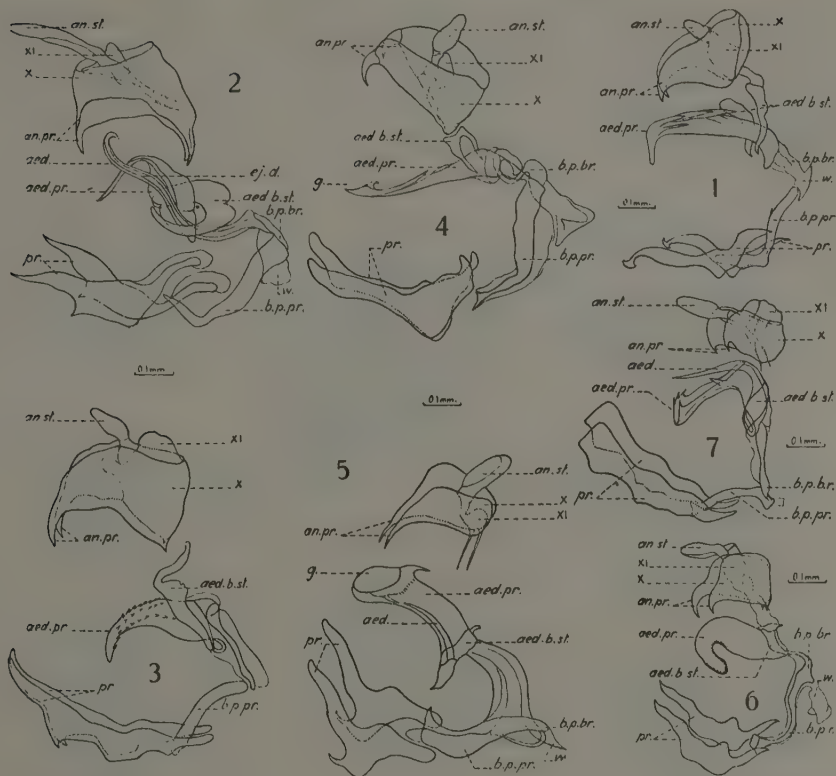
DESCRIPTION OF THE EXTERNAL GENITALIA***Megamelus fieberi* (Scott).**

Male (fig. 1) : The pygofer is conspicuous in a dorsal view, with rounded anal angles. In a lateral view, it is narrower dorsally and gradually enlarges towards the sternal side. In an end view, it is oval in shape with the long axis vertical. The tenth segment is broad and quite conspicuous between the anal angles which are wide apart. Anal processes are short and pointed at their ends which are slightly curved inwards. Anal style is short and conical. Diaphragm is thin. Armature is not well recognised. Aedeagus perianth is straight, long, flattened, bent sharply downwards at its distal end, on which there are long spiny processes directed towards the proximal end of the aedeagus. Aedeagus basal strut is composed of two plates, tapering towards their lower ends; their upper ends are slightly notched. Basal plates bridge is conspicuous, with wings. Basal plates prolongation is slender, curved slightly near its dorsal end and sharply in a right angle at its lower third. Parameres are slender, each tapers towards both ends and has an elbow-like projection facing the other one. The distal end is very peculiar and peg-like.

Female (fig. 9) : The ovipositor is long, extending a little beyond the posterior end of the abdomen. The first valvifer is an elongated thin plate. The second valvifer has an entire rounded posterior margin. The second valvula is extending behind the second valvifer. It is uniform in thickness after the protruded part on its outer margin. It starts far behind the genital opening. The first valvula is thin.

***Stenocranus minutus* (Fab.)**

Male (fig. 2) : On removing the wings, the pygofer is seen dorsally very narrow and the anal angles, which are acute, surround the protruded tenth segment. The pygofer gradually enlarges towards the sternal side. In an end view, the pygofer is more or less oval in shape, with the long axis vertical. The anal processes are spiny, straight, and long. The anal style is long and conical in shape. Diaphragm is chitinated and its armature is quite clear. Aedeagus is long, thin, and slender, slightly curved at the middle and sharply bent inwards at the distal end. Aedeagus basal support is plate-like with a notch at the top, it forms a ring around the aedeagus-perianth. The perianth is stout with a whip-like tip bent sharply downwards. The basal plates bridge is conspicuous, and the prolongation bends at right angle near its lower end which is in touch with the parameres. Parameres are thin, and their tips taper gradually and end in a pointed tip. The central portion is bulgy and broadened. There is a sharp pointed process on the lower edge of the paramere; it is directed outward the margin.



Male genitalia, lateral view (after removing the pygofer):

Fig. 1 : *Megamelus fieberi* (Scott). — Fig. 2 : *Stenocranus minutus* (Fab.). — Fig. 3 : *Criomorphus albomarginata* (Curtis). — Fig. 4 : *Criomorphus nigrolineata* (Scott). — Fig. 5 : *Dicranotropis hamata* (Boh.). — Fig. 6 : *Delphacodes pellucida* (Fab.). — Fig. 7 : *Delphacodes fairmairei* (Perris).

(aed., aedeagus; aed. b. st., aedeagus basal strut; aed. pr., aedeagus periantrum; an. st., anal style; an. pr., anal processes; b. p. br., basal plates bridge; b. p. pr., basal plates prolongation; ej. d., ejaculatory duct; g., gonopore; pr., parameres; w., wing of the bridge; XI, tenth abdominal segment).

Female (fig. 10) : The ovipositor reaches the hind end of the abdomen. The first valvifer is a broad sclerite, as well as the second valvifer; both reaching approximately the lateral margins of the sternites. The second valvifer bounds the posterior half of the second valvula up to its posterior end. The second valvula is uniform in thickness. There are no protruded parts on its outer margins. It starts very near to the genital opening.

***Crimorphus albomarginata* (Curtis)**

Male (fig. 3) : The pygofer is conspicuous in a dorsal view, with rounded anal angles. It is deeply notched, and the notch is triangular. In a dorsal view, it is narrower at the dorsal region and gradually enlarges towards the ventral side. The tenth segment is large, and the anal processes

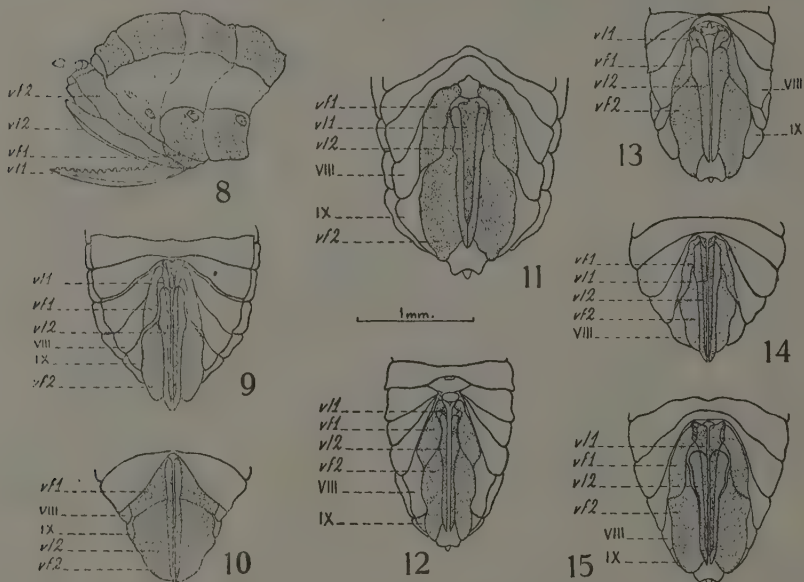
**Female Genitalia**

Fig. 8 : Lateral view of external genitalia. — Fig. 9 : *Megamelus fieberi* (Scott). — Fig. 10 : *Stenocranus minutus* (Fab.). — Fig. 11 : *Crimorphus albomarginata* (Curtis). — Fig. 12 : *Crimorphus nigrolineata* (Scott.). — Fig. 13 : *Dicranotropis hamata* (Boh.). — Fig. 14 : *Delphacodes pellucida* (Fab.). — Fig. 15 : *Delphacodes fairmairei* (Perris).

(*vl. 1*, first valvifer; *vl. 2*, second valvifer; *vl. 1*, first valvula; *vl. 2*, second valvula; *VIII*, eighth abdominal sternite; *IX*, ninth abdominal sternite).

are long, spiny, and slightly curved inwards. The anal style is short and spindle-shaped. In an end view, the pygofer is more or less triangular. Diaphragm is slightly chitinated, and its armature is not visible. Aedeagus perianthrium is conical in shape with its tip bent downwards, with teeth directed backwards, and placed in five longitudinal rows, one at the top and two on each side. The aedeagus basal strut is not stout, with a slender

tip directed inwards, and is sharply curved upwards at its end. The bridge is not conspicuous, and the prolongation is a convex rod. The two parameres are stout plates, with tapering proximal and distal ends, and each has two processes, one at the middle of the upper half which is sharp and pointing downwards, and the other is at the middle of the lower half and it is obtuse. The processes of one paramere face those of the other in a lateral view.

Female (fig. 11) : The ovipositor is not reaching the hind end of the abdomen. The first valvifer is broader than that of *M. fieberi* (Scott). The second valvifer has a tapered posterior margin with a deep convex part in the middle of its free inner margin. The second valvula is thinner behind the protruded part and then it thickens again and tapers towards its tip.

***Griomorphus nigrolineata* (Scott)**

Male (fig. 4) : In a dorsal view, the anal angles of the pygofer are pointed but not protruded outside. The tenth segment is also not protruded outside. The anal processes are spiny, and bent inwards. The anal style is slender and short. In an end view, the pygofer is oval with the long axis horizontal. The diaphragm is chitinated and the armature is clear. Aedeagus periantrum is straight, slightly bent near the distal end. The gonopore opens dorsally. It has two spines, one at the centre and the other near the distal end; they are directed towards its proximal end. Aedeagus basal strut is horse-shoe-shaped, with the open end facing downwards. The basal plates bridge is stout and conspicuous. The basal plates prolongation is bent at right angle near its lower end; like that of *S. minutus* (Fab.), but its end is not pointed but concavely flat. Parameres are slender, pointed at the top; each with a conspicuous elbow-like projection near its base, facing the projection of the other. In a lateral view, they appear like the foot of a man in outline.

Female (fig. 12) : The ovipositor is not reaching the posterior end of the abdomen. The first valvifer is moderate in thickness. Its anterior end is knobbed, with a deep notch where the head of the second valvula fits. The second valvifer has a more or less tapered posterior margin. The outer margin has a concave part in its lower half. The inner free margin is slightly curved. The second valvula has a thicker anterior end, and a thicker part near its centre.

***Dicranotropis hamata* (Boh.)**

Male (fig. 5) : In a dorsal view, the pygofer is produced out of the body for a considerable distance. The anal angles are acute, and produced caudally. In a lateral view, the upper region of the pygofer is larger than

its sternal one. It is heavily chitinated and black in colour. In an end view, the pygofer is triangular, with the base of the triangle at the dorsal side. The tenth segment is thin, sunk between the two anal angles. The anal processes are long, spiny, and slightly curved inwards. There is a spine near their anterior side. The anal style is a stout plate, conoid in shape. Diaphragm is slightly chitinated, and the armature is conspicuous. Aedeagus periandrum is stout, short, with three stout spines, one at the dorsal side and one at each lateral side near its distal end. They are bent towards the anterior end of the insect. There is a row of tiny spines between each two of the large ones. The gonopore is wide, placed at the distal end, and opens dorsally. Aedeagus is whip-like organ. Aedeagus basal strut forms a complete ring around the base, a little distance from it. Basal plates bridge is not conspicuous; and the prolongation is short, curved twice in different directions. Parameres are slender; they widen apart from each other towards their tips. Their basal parts are stout, each with a spine there, produced outside when seen in a lateral view after removing the pygofer. The inner edges are ridged.

Female (fig. 13) : The ovipositor is not reaching the posterior end of the abdomen. The first valvifer is very thin, due to the extension of the eighth sternite. The second valvifer has a tapered posterior margin; and the free inner margin is slightly concave. The second valvula is thick at its anterior end; there is no protruded part on its lateral margin. The anterior end of the first valvula is rounded.

***Delphacodes pellucida* (Fab.)**

Male (fig. 6) : On removing the wings, we see the pygofer in a dorsal view quite conspicuous; not deeply notched. It enlarges towards the anal angles which are acute. In a lateral view, it enlarges slightly towards the sternal side. In an end view, it is oval in shape with the long axis horizontal. The tenth segment is wide and the anal processes are curved spines, quite close to each other at the median line of the sternal region of this segment. Diaphragm is chitinated, and the armature is not clear. Aedeagus periandrum is stout and cylindrical. Its distal end is decorated with fine teeth. It bends sharply at its centre, with the distal half pointing downwards. Aedeagus basal strut is composed of two small plates around the proximal end of the aedeagus. Their upper ends are wider than the lower ones. Basal plates bridge is conspicuous, and the prolongation is slender and curved outwards at its lower third, with its end squarely flat and not pointed. Parameres are slender, tapering towards both ends; the central part is somewhat bulgy. At that part they bend sharply in a lateral direction.

Female (fig. 14) : The ovipositor extends a little beyond the posterior

end of the abdomen. The first valvifer is very thin. The second valvifer has a rounded posterior end, cut beside the second valvula. The second valvula is nearly uniform in thickness. The first valvula has a flattened anterior end.

Delphacodes fairmairei (Perris)

Male (fig. 7) : In a dorsal view the pygofer is quite conspicuous. The anal angles are acute, and taper sharply backwards, enclose completely the anal and preanal segments. The edge of the pygofer is curved deeply inwards when seen in a lateral view. In an end view, the pygofer is oval with the long axis vertical. The tenth segment is large at the sternal side. The anal processes are very small, and hardly seen in the end view. The anal style is stout, conoid and black in colour. Diaphragm is heavily chitinised and the armature is not conspicuous. Aedeagus periantrum is long and slender, bends at a right angle at its centre. Its distal end is toothed at the tip of its dorsal side. The teeth are directed dorso-anteriorly. There is another spine at the centre, directed towards its distal end. Aedeagus basal strut is a rounded plate at the base. The basal plates bridge is conspicuous, and the prolongation is short, slender, nearly straight. Its end near the parameres is slightly enlarged. Parameres are deformed triangular plates with the wider base at the distal end.

Female (fig. 15) : The ovipositor does not reach the posterior end of the abdomen. The first valvifer is moderate in width, uniformly broad; its anterior end is rounded and not pointed as in the previous species. The second valvifer has a rounded posterior end, and its free inner margin is straight. The valvulae taper sharply towards their posterior ends. The anterior lateral ends of the first valvula are nearly flat.

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The cigarette-beetle outdoors

[Coleoptera : Anobiidae]

by Dr. FREDRICH ZACHER

Like many other stored products pests, the cigarette-beetle (*Lasioderma serricornis* L.) larva can select among a wide variety of food-material. Because of its requirements of warmth, it can only develop in Germany indoors. As far as known to me, it has never been observed outdoors; even in warmer countries it has been found usually in store-houses, where it is extremely injurious.

The following is intended only as a selection of the large number of foods on which the insect can develop.

Tobacco in every form is preferred by the cigarette-beetle; it attacks cigars and cigarettes as well as tobacco, snuff and chewing-tobacco. In all the warmer countries it is by far the most dangerous pest in all tobacco-products. Only for the Philippine-Islands, Mackie estimates the value of rejected shipments, on account of beetle-infestation, at 250,000 dollars annually, and the losses supported by almost the local tobaccoists from 3000 to 6500 dollars per annum.

The cigarette-beetle, however, is not only indifferent to nicotine but, like the closely-related bread- or drug-store-beetle (*Stegobium paniceum* L.), is also indifferent to other vegetable poisons, and can therefore cause extensive damage in drug-stores and herbaria. The cigarette-beetle attacks a large variety of spices in grocery-shops and has even been found infesting insect-powder. For instance it has been found in strychnin, deadly nightshade, aconitum, curcuma-roots, ginger, nutmeg, ergot, rhubarb, cayenne pepper, anise, coriander, caraway (cumin), and liquorice. It also attacks cereal products such as flour, rice, corn, barley, vermicelli and biscuits; also pea-nuts, dates, figs, yeast-cakes, coco-press-cake, and even books and leather goods, presumably owing to the paste used in their production.

The range of the cigarette-beetle is a cosmopolitan one, limited by temperature and humidity requirements. The limits of activity for the beetle are between 18 and 47° C. The vital optimum is at 30° C with 80 % relative

humidity. Therefore the insect has the best chance for development in damp and warm regions.

The cigarette-beetle is wide-spread in Egypt. I found it in Cairo in wasted spices received from drug-stores, further in seeds of the cow-pea (*Vigna-sinensis*) bought in a seed-shop. Examples were also present on corn in a granary at Benha, in Australian flour at Alexandria, on dates at Port-Said, and on cotton-seed at Giza.

A further discovery was of special interest : on the 7th May, 1933, I collected some dried-up fruits of *Anona squamosa* at Ramleh (near Alexandria) hanging shrivelled on the tree, and kept them in a glass-jar. Several months after my return to Berlin, a large number of cigarette-beetles hatched out. So, it is now proved that in Egypt fruit on the tree outdoors has been attacked by this insect. This is the first instance where the development of this store-pest outdoors has been recorded.

Biological Studies of some Midges and their Relation to Disease Transmission, particularly the Horse-sickness

[Diptera-Chironomidae and Ceratopogonidae]

(with 15 Text-Figures)

by MOHAMED KAMAL, Ph.D.,
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FOREWARD

The tiny little flies attracted to lights when warm weather begins have never been suspected in the past to play an important role in the transmission of epidemic diseases. The frail body of the fly and their innocent appearance made them escape for some time as harmless creatures.

However, these world wide distributed flies with the discovery of their association and relationship with certain diseases in man and animal, did not seem to stimulate enough enthusiasm on the part of research workers to investigate fully the biologic relationship existing between these insects as vectors and agents of pathogenic animal diseases.

The study of this relation to the causation and spread of disease in man and animal has long been confined to the laboratory as a subject of purely academic research and has not stepped to full applied studies designed to obtain precise physiological and ecological information until recently.

Workers on this group of insects are generally confronted with the great handicap by the widely scattered, unorganized and often inaccessible literature. In order to correct this situation, the writer has attempted to get this information together by reviewing herein whatever possible material and knowledge he can get hold of.

Due to the smallness of size of these flies and the dependence on genitalia for specific identification, it is important, therefore, to consult specialists for their determination. Without this correct information, time and effort are considered wasted especially when we try to propose a control mea-

sure, such as that devised in the last campaign in Egypt against the outbreak of the horse plague in which we have been misled with by the origin and specific agent of the infection.

I must confess that a great deal of work on our midge Fauna remains to be done from both points, the systematic and the bionomics; and unless these are fully solved we are liable to fall into misinterpretation in our attempt to designate their association with specific animal diseases.

INTRODUCTION

The serious outbreak of the South African horse-sickness in 1943 in Egypt in an epidemic form after its first record in the country in 1928, and the suspicion of the midges as being involved in the transmission and spread of the disease, made it quite imperative for an entomologist to take charge of this problem and try to tackle it from an entomological view point. This has to be done in conjunction with the great efforts carried out by the veterinary section of the Ministry of Agriculture. Therefore, it has not been considered out of place to publish a treatise on these flies for the purpose of supplying workers on the subject with the possible information available.

The Egyptian Government, on the other hand, realizing the gravity of the situation of the disease, requested the South African Government for scientific help and as a result of mutual contact of the two respective governments, the services of Dr. R. A. Alexander, the specialist on the subject, have been made available for us here. He left his laboratory at Onderstepoort and arrived in Egypt about the end of July 1944.

The discovery just been made by Du Toit in South Africa that a certain species of biting midges has been found responsible for the disease, has become surprising to us as well as important. It has brought alarm to veterinarians and entomologists for the sole reason that Egypt is a country with vast range of streams and canals which offer suitable places for breeding. This scientific discovery made us look with suspicion to these tiny two-winged insects that have never been thought to be convicted as agents of disseminating such serious disease that has been threatening our equine family with annihilation.

Consequently, this new field of interest has enthused the writer to undertake the task of trying to elucidate this relationship and in addition to put before the workers a revision of the works on the midges as a whole, chiefly whatever available information accessible concerning their bionomics and disease connection.

The writer does not claim, however, that the data recorded herein is in any way complete but he wishes to admit that it is only an initial attempt

to mould together scattered knowledge into a more comprehensive form in hopes that the student concerned with the subject may find at his disposal the information necessary in helping to get a good start for a much deeper knowledge of insect epidemiology which the opportunity and the challenge are compelling us to meet in the future.

This basic knowledge is particularly of great interest to a country like Egypt situated at the cross-roads of all nations. With the rapid progress of world's lines of communications, it has become important to guard against insects which play a great part in our welfare particularly with respect to the transmission of disease agents affecting man and animal. Our country has suffered a great deal lately as a result of the accidental introduction of agents like the Gambia mosquito, the horse-sickness, and the typhus fever. Thousands of lives have passed out and heavy material losses have been suffered, and with combined efforts of scientific men, we wish to put an end to these exotic disasters.

ACKNOWLEDGMENT

The author wishes to express his deep gratitude to the veterinary section of the Ministry of Agriculture particularly to its past and present chiefs for the various help and information granted during this work. I must also admit by indebtedness to Dr. Alexander for his suggestions and encouragement which gave me the impetus to start this problem in spite of the difficulties involved and the scarcity of available literature at my disposal. Due acknowledgement is also to be recorded to the sources of the figures and text quoted in this paper particularly to the work of Du Toit from which the author has copiously availed himself with information.

THE PREVALENCE OF THE MIDGES

With the advent of summer in Egypt, great numbers of tiny delicate mosquito-like insects hover in the air towards the evening and exhibit a characteristic gregarious habit of dancing and humming in the air in swarms. They are known as midges (Hamoush), and have been driven by the wind from their breeding places along the Nile banks and are so attracted by the city lights in millions thus causing annoyance to pedestrians, and vehicle drivers, and shop keepers. The Nile in April and May with its very slow running water, its rich contents of green algae (*Spirogylla*) and its numerous muddy canals, affords ideal breeding places for the midges. These flies are very common all over the country in this time of the year. Although aquatic in habits and their distribution is limited to the vicinity of waters, they are nevertheless, found in large numbers at a considerable distance from any water supply.

For the most part only the males swarm. Occasionally, however, very few females may be found in the swarm. The females may also occur under foliage at rest by day time.

In the summer resort districts of North America along the Atlantic Coast the same insects constitute a serious economic problem particularly in localities neighbouring fresh water sources and in intra-tide water pools.

DISTRIBUTION

Midges are widely distributed all over the world. Perhaps over 3000 species are reported from various European and American Countries and from Africa. They occur in North America as well as in South America. In Africa they are common in South Africa, Kenya Colony, Tanganyika, Rhodesia, Abyssinia, West Africa, Egypt and the Sudan, i.e. where horse-sickness is reported to occur.

SYSTEMATIC POSITION

The attitude of the author with regard to the classification of this old group is in conformity with the one commonly adopted by recent taxonomists in their publications. The group is divided into two major families:

(1) The common of non-biting midges which belong to family Chironomidae.

(2) The biting midges or gnats which fall under family Ceratopogonidae.

It is evident, therefore, that the basis for adopting this type of classification is chiefly built on the assumption of differences in the organs of ingestion and on some other morphological characters rather than on the bases of phylogenetic descent which when pursued leads to very confusing results particularly with respect to the affinities of some species.

I. FAMILY CHIRONOMIDAE (gnats, or non biting midges)

This cosmopolitan family may be mistaken for mosquitoes, although its members are easily distinguished from the latter by several characters. Members of this family comprise only the true or non-biting midges due to the fact that their proboscis is different from that of true mosquitoes by being short and not adapted for piercing. They are small slender flies rarely over 10 mm. in length. Their wings are narrow and lie roof-like over the back when at rest, bare or haired, but bear no scales. Antennae are slender, 5-14 segmented, plumose in the males, and sparsely haired in the females. Thorax is large, projecting over the head, without a transverse suture, but the metanotum with a more or less distinct longitudinal groove in the middle, the scutellum small and hemispherical. The legs are thin, fore-legs long

and slender. The head is small, more or less spherical, and partly concealed by the projecting thorax; palpi 3-jointed. Abdomen long and narrow, especially in the males, shorter and more robust in the females.

The larvae of most chironomids are aquatic and of considerable importance as fish food. Some of the larvae are bright red in colour and are known as blood worms. This colour is due to haemoglobin dissolved in the blood. Surface-haunting larvae are, however, green. Larvae usually live in tubes free or attached to stones, the tubes being made of mud portions or vegetable matters from the substratum.

NOTES ON THE BIOLOGY OF CHIRONOMUS

The biology of this group has not been thoroughly worked out; nevertheless, some information on the phases of their life appears scattered in various sources of information which throw very little light on its biometrics.

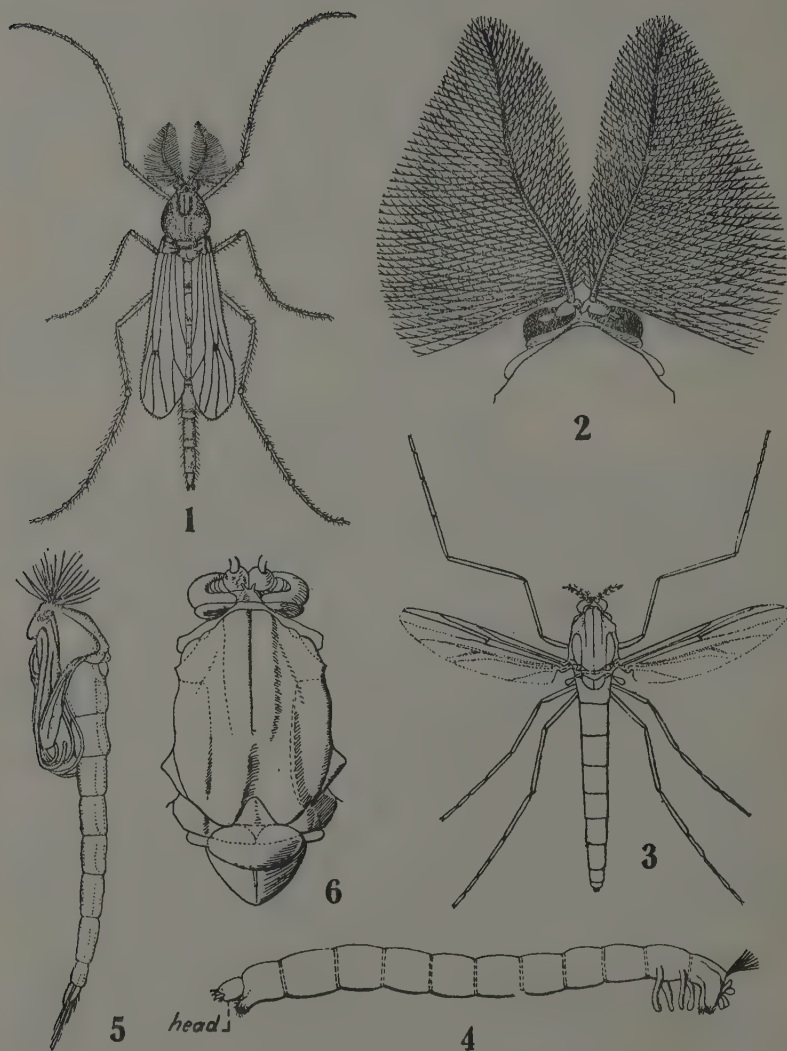
The midges lay their eggs in masses or ribbon-like, and they vary in shape, number, and arrangement. They are generally enveloped by mucilage secretion. The eggs hatch into larvae, which are noted for the great diversity in form and adaptation. Some are able to live at great depths and come to the surface only occasionally, while a few are able to tolerate salt water. The larval tracheae are closed or rudimentary, consequently they are considered destitute of this system.

The pupae may be active floating at the surface of the water, or remain buried in the mud under water. The pupal respiratory organs, therefore, either consist of a pair of much branched tufts of hair-like filaments on the thorax or simple tubes, which are different from the pair of trumpet-like protrusions common in other Diptera.

The far advanced pupae and the newly emerged imagines are capable of reproducing parthenogenetically by laying eggs in a manner similar to the noted fly, *Miastor*. Grimm, believes that the offspring produced in this manner are all females and this generation only occurs in the spring.

SOME SPECIES OF IMPORTANCE

There are several important species belonging to family Chironomidae, the discussion of which will be out of the limited scope of this paper; but since some species presumably reflect some significance to our main objective, it was then thought desirable to discuss a few of the most important as typical examples of the group. This will aid in differentiating between the individuals of the two allied families and will help to explain the relationship existing between them.



Chironomus plumosus (non-biting midge)

Fig. 1 : The male. — Fig. 2 : Head of same [after Smart]. — Fig. 3 : The female [after Smart]. — Fig. 4 : The larva. — Fig. 5 : The pupa. — Fig. 6 : Head and thorax [after Smart] (note the longitudinal groove and the absence of ocelli on the head). [Magnified].

Chironomus dorsalis

This species is recognized by having a well developed head and twelve trunk segments, also by a pair of pseudopods on the prothorax and last abdominal segment. Two pairs of elongate body-gills may be present on the eleventh segment and two pairs of papilla-like anal gills are placed around the anus. The tracheal system is limited to the thorax where there are two pairs of closed spiracles.

Chironomus plumosus

This species (figs. 1-6) is considered to be the most representative of the group.

LIFE HISTORY

The eggs are laid in a batch averaging about 2300 in summer and are enveloped by transparent mucilage. They hatch within three days in the summer. The larvae are worm-like, red in color, aquatic or semi-aquatic, and move by looping or creeping. After three weeks the larvae become fully mature. It has been observed that the larvae become luminous or phosphorescent due to the presence of active bacteria in the body of the gnat.

The respiratory system is closed, therefore, it does not come to the surface for air as do mosquito larvae. There are at least four generations a year with an overlapping of the cycles which ensures a fairly constant supply of adults and eggs.

The breeding season begins at the end of March and continues throughout the summer until almost the beginning of November when the species begins to overwinter in the larval stages. The rate of mortality in the egg stage is low, but in the larval stage it is high. The loss occurs in the first 8-10 days of larval life. Some larvae have been taken in great depths in lakes, and some species breed in swiftly running water. Imms (1934) states that vast numbers of this Chironomid (*Chironomus plumosus*) frequent the salt lakes adjoining the Suez Canal.

Careful examination of swarms of this species reveals the fact that the number of females present appears to be comparatively very small because when pairing — which takes place on the wing — is accomplished, the mated females leave the swarm to the breeding grounds. Most authors claim that no food is taken during the adult life and consequently the digestive canal is shrunken and empty.

FOOD, HABITS, AND BREEDING GROUNDS

The great majority of Chironomids are bottom feeders and scavengers in habits occurring most abundantly in shallow shore waters where decayed

humus, such as algae, moss and any organic matter are to be found. Edges of pools and marshes densely shaded with reeds, etc., offer favorable grounds for breeding.

OTHER SPECIES

There are two more important species namely, *Chironomus tentans* and *Chironomus cristatus*, the biology of which is not completely worked out, but it coincide in many respects with the life history, *Chironomus plumosus*.

CHIRONOMIDS AND DISEASE

Since the larvae of *Chironomus* live in sewage, they are thus capable of acquiring bacteria during the larval stage and of disseminating them later during the adult stage. Although, it has been stated by Steinhaus (1946) that most of the bacteria are of the sporadic forms, Liger (1902) on the other hand observed three forms in *Chironomus plumosus* which are considered to be truly parasitic.

Leach (1933) has cited interesting example of the survival of bacteria during the metamorphosis of the seed-corn maggot, *Hylemya ciliatura*, which transmits the potato-leg disease. The maggots pick up the disease germs from contaminated soil or potato-seed pieces. During pupation in the soil, the bacteria survive uninjured in the digestive tract of the puparia and emerge with the adult fly.

Relationship similar to that has also been reported to exist between the olive knot disease and the puparium of the olive fly, *Dacus oleae*. Besides the possibility of transmission of bacteria during metamorphosis, there should be mentioned also the phenomenon of transmitting it from one generation to the other.

Thus, Chironomids are not only haunted by bacteria but also possessed by protozoa. Porter (1909) reported a species of amoeba (*Amoeba chironomi*) to be found throughout the gut of *Chironomus plumosus*, but whether it is pathogenic or not he has not explained.

II. FAMILY GERATOPOGONIDAE CHARACTERS AND BIOLOGY

The individuals belonging to this family are slender flies rarely 5 mm. in length and are known as punkies or biting gnats. The males do not bite, but the females in their biting habit resemble the black flies known as buffalo gnats (Simuliidae). The mouth parts form a proboscis which is not exceptionally long.

The family was formerly included in the Chironomidae, but Malloch,

Edwards and later workers as well as Smart, recognised it as a distinct family. It is easily distinguished by the shape of the thorax which is oval and shorter than in Chironomidae; pronotum never prominent; metanotum

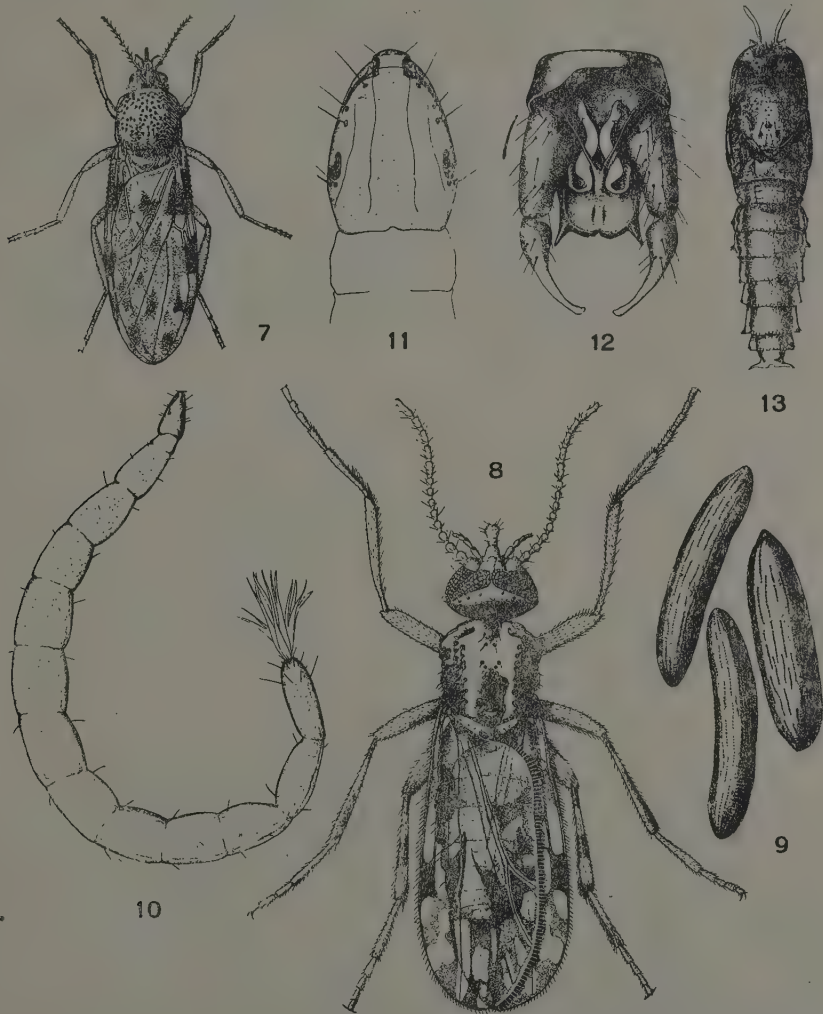


Fig. 7 : An adult biting midge, *Culicoides austeni* (Ceratopogonidae), with the wings folded over the back at rest [after Smart]. — Fig. 8 : *Culicoides devei* Hall. — Fig. 9 : Egg of same. — Fig. 10 : Larva of same. — Fig. 11 : Head of larva of same. — Fig. 12 : Male genitalia of same. — Fig. 13 : Pupa of same [after Dove, Hall, and Hull]. [Magnified].

rather rounded, never with longitudinal groove; scutellum small, usually bearing distinct bristles. The wings, when folded, rest flat over the back; they tend to be ovate and are frequently spotted. Antennae not compact, and consist of a series of fourteen similar visible segments, apart from the basal two which are very small and almost unnoticeable.

The vermiform larvae, which are about 7 mm. in length, live aquatic, semi-aquatic or terrestrial life. They are found amongst blanket algae in ponds, and amongst algae in springs, streams, and lakes. Most of the marine species live within the tide zone and for that reason there is no practical means of control that could be prescribed.

The pupae of the aquatic forms float over the surface of the water and move very little. Consequently, the family falls into two groups: those with aquatic vermiform larvae, whose imagines are more or less bare-winged, e.g. *Culicoides* and *Bezzia*, and those with terrestrial larvae found in sap tree holes, or decaying organic matter, e.g. *Forcipomya* and *Dasyhelea*, whose imagines have hairy wings.

This is a very large family comprising close to 2000 described species. The individuals are gregarious in habits, occurring in large numbers and causing great nuisance to man and animal as a result of their bites.

The midges belonging to this family often form serious pests especially along the sea-shores in the tropics, and along rivers as well as lakes. The adults are either predaceous or extremely parasitic.

The larger species are known to prey upon small insects while the smaller forms suck blood. They have been observed to attack mantids upon which they feed. Some species are known to be vectors of filarial worms of the genera *Onchocerca* and *Acanthocheilonema*.

TECHNIQUE IN HANDLING THE MIDGES

The minuteness of these insects and their tenderness make them very difficult to handle. Therefore, special technique should be designed to capture the insects alive and intact. The methods adopted are very much similar to those followed by Du Toit. Midges which are seen busy in biting their prey can be captured by placing a shell vial over them while they are engaged in sucking the blood. The collector should exercise great care and self control during the process owing to the possibility of meeting several midges which begin feeding at the same time.

Due to the delicate nature of the hairs on the wings they are apt to be easily abraded and thus the characteristic wing pattern disappears. For this reason dried specimens should always be preserved; some may be mounted on slides, some kept in alcohol, while others could be spread on card points.

Another method of collecting these tiny insects is by means of light

traps preferably connected with an electric current as designed by Butts (fig. 14). Any other similarly designed light trap may serve for the purpose.

Larvae in algae are removed by placing the algae on a screen over a

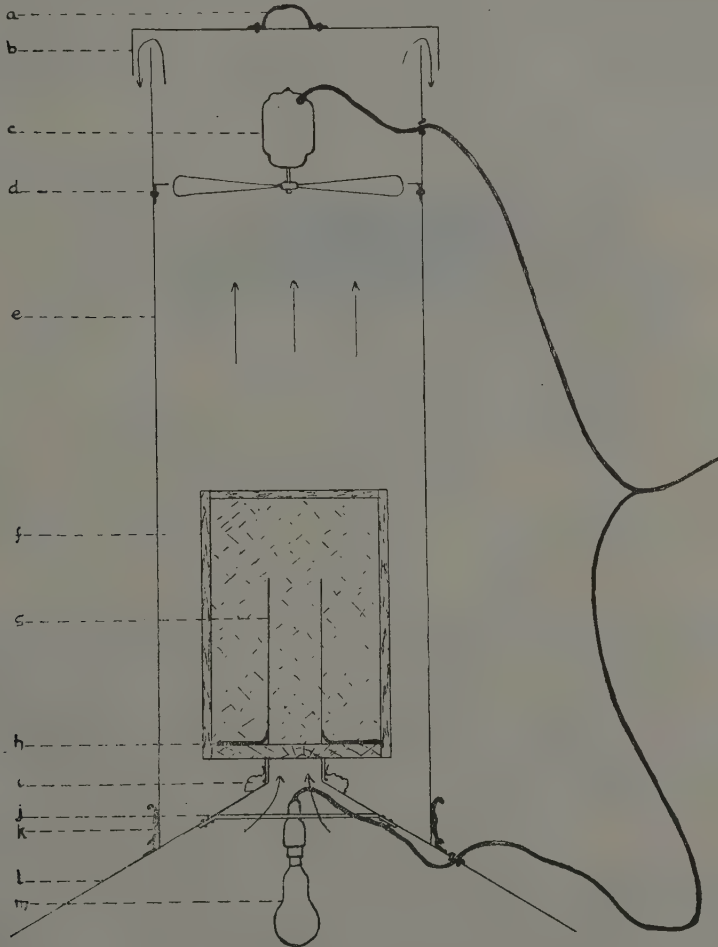


Fig. 14 : Light trap illustrating the following : *a*, metal loop for suspending the trap; *b*, dustbin type cover; *c*, electric fan with 7 inches blades; *d*, metal flange to allow 1/8 inch clearance for fan blades; *e*, cylindrical sheet metal body of trap 8 inches diameter; *f*, catching cage; *g*, sheet metal inlet pipe or tube; *h*, felt or thick woolen cloth glued around opening of catching cage to act as seal between this opening and inlet tube; *i*, muslin sleeve; *j*, metal bracket to support lamp; *k*, spring clip attaching conical hood to body of trap; *l*, conical sheet metal hood 17 inches wide below; *m*, 75 watt electric lamp. — The arrows indicate the direction of the flow. [after Du Toit].

silk bolting cloth bag and washing them under a strong stream of water. If larvae are buried in mud they are separated in likewise manner by sifting the mud with water over a porcelain dish or placed in a recovery cage as shown in figure 15. The larvae are then readily seen swimming at the edge of the pan or over the bottom or in the fruit jar.

Each specimen is then kept in a separate shallow dish with water and material from the natural environment of the larvae, or water to which is

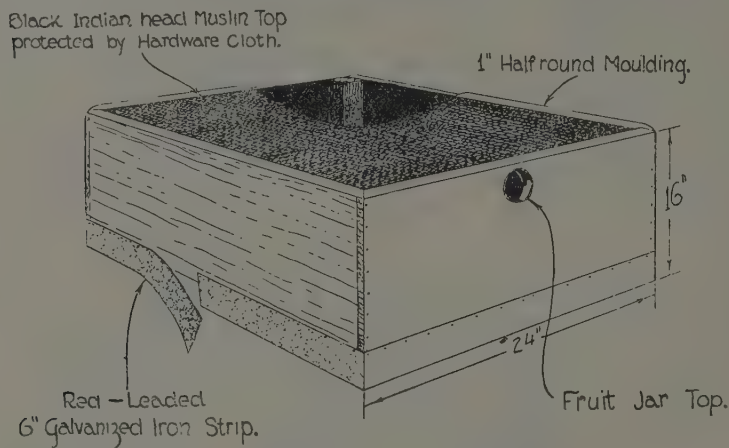


Fig. 15 : A diagrammatic illustration showing a breeding cage for the recovery of the midges emerging from soil or any other substratum (after Dove and Hull).

added one or two drops of milk. The carnivorous larvae require frequent feeding — which consists of newly hatched Chironomid flies, and of trichopterous larvae — because if food becomes scarce the larvae become cannibalistic. The victim is often one of their fellow members in the prepupal stage.

The pupae are placed separately in cotton-stopped vials lined with wet blotting paper. After emergence the flies are transferred to dry vials. Attempts have been made here and by various workers as well, to feed the adults in captivity in order to obtain eggs, but these were not successful, because they were not noticed to mate.

Larvae and pupae are best killed by immersing in boiling water before they are preserved. For preservation of the adult flies, a mixture composed of 80 parts of 95% alcohol, 15 parts of 10% formaline and 5 parts of pure glycerine is highly recommended. Adults mounted on card points are placed on their sides with the legs outward and fastened best with chellac.

ECONOMIC IMPORTANCE OF THE FAMILY

Larvae and pupae constitute an important item in the food of nearly all carnivorous young fish. Fish hatcheries give a great deal of attention to the artificial breeding of these insects, thus chemical fertilisers and meal manures are added to pools devoted to fishes for the encouragement of breeding the midges.

The ceratopogonids, on the other hand, are of greater economic importance in serving as insect vector in their relation to man and animal. Warm blooded animals are freely attacked by representatives of this family and the blood sucking habit is highly developed in this group. These tiny creatures with their short piercing proboscis make man miserable by suffering from their constant biting.

Parker (1933) in his studies regarding the association of Arthropods to the tularemia bacterium (septicemia), found out that the bacterium is able to survive in an undetermined species of Ceratopogonidae from larvae to adult and therefore it is capable of transmitting the tularemia organism. It is reported by Bell (1945) that infected arthropod feeding on immune hosts lost their infection. If this theory holds true in the case of horse-sickness, it will be consequently of great importance to immunize the horses by injecting them with anti-horse-sickness serum.

The genera most commonly known to attack man and animal and which are known to transmit certain diseases are the following :

(1) *Lasichelea*, widely distributed and cosmopolitan.

(2) *Dasyhelea*. — Keilin (1921) observed bacteria in the larva, pupa and adult of *Dasyhelea obscura*. Buchner (1930) studied this genus and found that *Dasyhelea versicolor* and *Dasyhelea flavifrons* contain similar symbiotic bacteria. *Dasyhelea longipalpis* was found devoid of symbiotes.

(3) *Haemophoructus*, common in the East Indies.

(4) *Leptoconops*, widely distributed and cosmopolitan.

(5) *Ceratopogon*, of common occurrence all over the world.

(6) *Culicoides*, widely distributed all over the world.

The purpose of this work is to review some of the genera of the greater economic importance in connection with disease especially the horse sickness, the writer, therefore, will confine himself to the study of the latter until further additions are made on the midge Fauna of Egypt.

1. Genus CULICOIDES

This genus is of cosmopolitan distribution and comprises several species which attack man and animal. Six species are already known to occur in Egypt (*Culicoides nilotes* Kieffer, *pharao* Kieffer, *donatieni* Kieffer, *puncti*

collis Becker, *sciniphes* Kieffer, and *pilosipennis* Kieffer). The adults are easily distinguished by the appearance of the wings which bear iridescent blotches or spots and covered with erect hairs; antenna 14-segmented and palpi usually 5-segmented. The larvae breed in pools, ponds and water standing in tree stumps. They live chiefly in fresh water with the exception of one species occurring in salt water. Quite characteristic of this genus is the tendency of the pupa to float in vertical position in the water.

The most important foreign species belonging to this genus are :

Culicoides canithorax, *mellius*, *furens*, *devei*, *pallidipennis*, *guttipennis*, *austeni* (intermediate host of human filariid, *Dipetalonema perstans*), *grahami* (transmits human Filaria), *sanguisugus* Mall. (blood thirsty species in North Western America), *pergrinus*, *biguttatus*, *pungens* (transmits *Onchocerca gibsoni* in Malay), *nubeculosus* (transmits *Onchocerca cervicalis*), *pallidipennis* (transmits blue tongue in sheep and horse-sickness), *pulicaris* L. (sucks the inner contents of caterpillars and other insects).

In Tropical Africa, particularly in the Camero, two of these species, *Culicoides austeni* and *Culicoides grahami* are of great economic importance. They are known to play as intermediate hosts of the Filaria worm, which is a common parasite of man there.

The life history studies of these two species and other related species give some idea about the habits, behavior and manner of life which most of these species are able to undergo and the important role they play in the welfare of human and animal communities.

Culicoides austeni

This species (fig. 7) measures 1.5-2 mm. in length, is humpbacked, and possesses dappled wings. The proboscis is short and relatively thick. The eight-segmented abdomen tapers more to a point than in the case with most flies. Only the female is known to bite man. It is a determined night biter and thus darkness is essential. Full moon nights gives almost complete protection. Wind is noticed to be deterrent while rain is not.

Flies in captivity are induced to feed in day time by the simple expedient of procuring darkness for them and by offering a man's arm for feeding purposes. This species of *Culicoides* requires two blood feeds in order to complete ovulation, the second feed is not later than the fourth day, and its usually carried on the third. It was found that flies captured in the net had either ova quite undeveloped or showed about three days development, and only rarely did they bite when the ova had reached the sixth and seventh days. After oviposition, the fly has been readily noticed to accept a second blood feed.

Oviposition in confinement of mature and immature eggs is usually

complete and the eggs emerge in a long line much similar to a string of sausages, though occasionally one or more ova might be found unexpressed. On few times the eggs were laid on the side of the test tube. The number of eggs varied from 92 to 141 and it is probable that 120 is the usual average number deposited. Hatching occurred from 40-100 hours after oviposition but the majority emerging on the fourth day. To secure a good hatching, a rotten vegetable matter (leaf) and some fresh water were introduced into the test tube, providing that the water should not be permitted to cover the eggs. It has been noticed that the retention of ova caused the death of the female in a number of cases. A very high degree of humidity is essential to the well being of the fly and to the development of the ova. Spring and fall seem to be the most productive months of the year (Sharp, 1928). This species is known to be an intermediate host of the human filariid, *Dipetalonema perstans* and hence it has become a pest of great importance to human life.

Culicoides devei

The life-history of the species (figs. 8-13) is very much similar to that of the foregoing one. When larvae were kept at low temperature and were supplied with brackish water twice weekly they lived from 3-5 months but did not pupate. Cool temperature appears favorable for the larvae and causes them to possess unusual longevity. On the other hand, larvae do not stand the temperature of the summer and therefore when exposed to direct sunlight they die within a few minutes. The pupal period lasts from about 4-7 days and under normal conditions the adults live for only about 10 days. Adults require 3 to 4 blood meals before they deposit eggs.

Culicoides pallidipennis

This species is first reported by Du Toit in South Africa to be the vector of the horse plague. Since his discovery has not been preceded by other workers, it is considered to be a new contribution to science.

The biology of this very important species nor its distribution has not been fully worked out; but as the disease has sporadically spread into several localities and assumed to play havoc to the equine family, it has been evidently considered of primary importance to determine first the relation between the horse infection and the prevalence of the insect pests, the biology of the species has to follow later. Thus much more time and work have been devoted to the study of the transmission of the disease which will be fully discussed in this paper.

Culicoides sanguisugus

In 1924, Hertig and Wolbach found rickettsia-like cocci, diplococci, and other rod-like bodies in the abdomen of this biting midge. The fate of the bacteria is not known, but it is proposed that they may be transmitted during the process of metamorphosis and consequently the midge may be accused to act as a reservoir for bacteria pathogenic to man (Steinhaus, 1946).

2. Genus LEPTOCONOPS

The genus is well represented in Egypt and has been reported from several localities in the country. It has a world distribution and comprises several species, the following are considered to be the most important.

Leptoconops torrens

It is a small species rather slender and almost about 2 mm. long. This genus differs from *Culicoides* by the number of antennal segments which are 13 in the female and by the palpus which is 3-jointed, the second joint is enlarged and swollen.

It begins to appear from April in the vicinity of rivers and is a vicious biter, and very troublesome on hot dull days or in the shade in bright sunny weather. It is reported from North America as a pest to horses in the southern states.

Leptoconops kerteszi

This is another very important species occurring chiefly in the United States and constitutes a serious pest in California in territories adjacent to rivers. It is reported that the black alkali locations seem to form foci from which the pest is blown by winds over wide area.

In some seasons the flies become so abundant and constitute such a menace to the agricultural field workers that in some sections the work had been brought to a stand still and even town dwellers were driven in doors until night-fall. The bites are exceedingly irritating causing nodules and inflamed swellings that itch persistently for several days or even weeks.

Leptoconops americana is a similar species very common in Northern California and reported to be a fierce biter to man.

3. Genus CERATOPOGON

For detailed study of the taxonomy of the group Ceratopogoninae the reader is referred to the works of Saunders (1924-25), Edwards (1926), Kieffer (1919) and Johansen (1905). Members belonging to

this genus are extremely annoying to man on account of their bites, and several species of great importance have been reported among this group, chief of which is *Ceratopogon guttipennis* which is common in hot climates and designated as a serious biter. Other species of allied importance reported from Western U.S.A., are *Ceratopogon stellifer*, *variipennis*, *unicolor* and *solstitialis*.

The gut of the larva of *Ceratopogon solstitialis* was found to entertain protozoa which is no way injurious to its host (Steinhaus, 1946).

THE TRANSMISSION OF HORSE-SICKNESS AND THE RELATION OF *CULICOIDES PALLIDIPENNIS* TO THE DISEASE

Horse-sickness or horse-plague, scientifically known as *Pestes equorum* ⁽¹⁾, is a very important virus disease prevalent in South Africa among horses.

The transmission of the disease to horses has been a subject of much speculation among veterinarians and entomologists until lately when Du Toit (1943) discovered in South Africa that a species of sucking midge known as *Culicoides pallidipennis* plays as an intermediary host in the transmission of the disease. Although *Culicoides* have been recorded to transmit some diseases such as filariasis to man in West Africa, it have never been suspected to be a vector of one of the most serious diseases of horses.

Du Toit, in his experimental work on horse-sickness presented here by Dr. Alexander (1944), had proved conclusively, by means of intravenous injections of *Culicoides* extracts caught at light traps, that the disease could be transmitted to healthy animals, thus concluding that this insect harbors the virus in a pathogenic state. His first trials, however, failed to prove that the flies fed on diseased animals, were able to transmit the disease to susceptible ones through direct feeding; but later experiments have been successful in transmitting the disease through host biting.

Infection of the midges is likely to occur through ingestion into the gut of infected blood. Further work indicated that this infection is not by no means transmitted from the female through the egg to the next generation. This method of transfer may not be the only principal one for the transmission of the disease because experimental evidence has shown that contaminated blood mechanically introduced into a healthy pest produces the symptoms of the disease. Various other dipterous flies have been suspected as disseminators of the disease such as the *Gambia* mosquito and the

(1) In Egypt, the Sudan, and several Middle East Countries, this disease is called *El Negma*.

horse fly, but no substantial evidence has yet been brought to justify this belief. Several instances, however, have been reported in which insects other than the incriminated ones may serve to disseminate the disease.

Du Toit carried out series of experiments on disease transmission by *Culicoides* by allowing a large number of them to collect at night on a light trap. These flies were finely ground with 10 % horse serum in saline, then centrifuged, and injected intravenously into a horse. After a short time, which we may leniently call the period of incubation, typical symptoms of the disease have appeared on the animal concluding, therefore, that the flies work as intermediary host for the disease.

It is admitted that the methods for handling viruses is very complicated and one should be very careful in developing his own techniques which vary with the agent concerned. Viruses may be isolated from infected insects by allowing the latter to feed upon a susceptible plant or animal, or as stated by Steinhaus « by inoculating the triturated insect into these hosts. Viruses pathogenic only to insects must be maintained in insects or, as shown by Trager (1935), in tissue cultures. In triturating infected insects preparatory to inoculating them into animals or plants it is advisable to use a diluent other than saline, which exerts a deleterious effect on some viruses. Tyrode's solution appears to be a satisfactory diluent ».

HORSE-SICKNESS IN EGYPT

Since this disease had occurred suddenly and sporadically in some parts of Upper Egypt in 1943 after its first advent in 1928 in the same locality, it was proposed that its recurrence has been attributed to freshly introduced infection from some source in Africa either by air transportation or through accidental entry of some infected or carrier animals.

The coincident appearance of horse-sickness in Egypt in 1943 synchronized with the appearance of the malaria fever transmitted by the new intruder the Gambia mosquito, made many workers believe that the latter is responsible for transmitting the disease. This idea was however, refuted by later investigations on insect vectors and by the rapid spread of the disease which extended to localities in the Delta beyond expectations and passed particularly the foci of infection by the Gambia. The spread of the disease was so rapid all over the country that the whole equine population was threatened with annihilation unless strict quarantine measures are promptly taken to stop the transportation of diseased animals. As it was also learnt that the donkey played an important role in the dissemination of the disease by acting as a natural reservoir for the infection, these indispensable animals to the Egyptian farmer were also guarded against until almost transportation means were threatened to a standstill.

VIRULENCE OF THE DISEASE

In view of the fact that some recoveries have occurred among sick animals in Egypt, Dr. Alexander claims that perhaps the strain of the local virus is less virulent than that in South Africa, or, as he says, that the insect may lack a certain plant-food which has something to do with the activation of the virus. This food was related to the big plantations of sugar-cane common almost all over the provinces where the disease first appeared. It is generally agreed that environmental conditions have some bearings on the virulence of the disease. In south Africa, for instance, the virus activities at the advent of the first frost gradually drop down until a condition of insect-disease-free is obtained. What constitutes the less virulent condition or supposedly the new strain in Egypt is not yet known. It may be expressed that the intensity and accumulation of heat units during the prolonged period of the dry hot summer of Upper Egypt, may act as a retarding factor in the expression of virulence of the disease through the process of attenuation of the virus. The work done on the grasserie disease attacking the silk worm and how it is affected by temperature may stand as a criterion in support of this advanced conception. Another alternative can be promoted which indicate that the insect vector in Egypt contains fluids or enzymes that possess the power of reducing the virulence of the virus.

Literature consulted on the subject of variation of virulence in insect vectors agree with my belief that what we call insect disease-free after the frost is not really disease-free but the causative organisms dwindle under the forces of unfavourable environmental conditions to such a degree of weakness that some writers call them weak strains or forms. Consequently, the virus during the winter is non-symptom producing and frequently can be considered as immunizing virus and therefore, when transmitted does not produce symptomatically recognisable infection until its level of virulence is raised either by optimum heat or by ingestion of fresh supply of host blood. Since we cannot with our present knowledge judge « whether a virus is composed of one strain or several strains acting harmonious together or under some conditions against each other, therefore, we are unable to deduce anything definite concerning the concept of the virus virulence » (Smith).

RELATIONSHIP BETWEEN VIRUS AND THE MIDGES

The well known example of the transmission of malaria by the anopheline mosquito can be taken as a partial analogy with our present study of the horse-sickness virus and the biting *Culicoides*. There is, however, in the former case an undoubted organism that can be detected with the aid of the microscope and which we cannot deny the changing phase which it

undergoes in its life-cycle within the body of the mosquito. With the latter case, we have not such evidence, as we cannot see it in the insect's body but we can only draw certain deductions from the joint behavior of insect and virus.

It is a known fact that some plant viruses cannot be transferred from a diseased to a healthy plant merely by the transferring sap from the former and injecting it into the latter. In several instances this phenomenon can only be spread by the medium of a particular kind of insect and in some cases by only one insect species. Experimental evidences have shown us that with this type of transmission a period should elapse after the insect has fed on the virus-diseased host before it can transmit the disease to a healthy one. This means that during the period of delay in the insect the virus is undergoing some kind of change within the insect's body allowing it to multiply in the new host. Our present knowledge does not give us definite information as to what sort of changes this supposed alteration may be or in what way does the insect attune the virus for its entry into the fresh host. It is however, permissible to speculate on this relationship and on what happens to the virus when it is swallowed by the insect. It is admitted that the virus requires the presence of insect saliva to multiply and that is why some viruses require insects as intermediary hosts and even a particular kind of insect. The virus passes through the wall of the alimentary canal into the blood and thence to the salivary glands where it is injected by the piercing mouth parts into a fresh host. Therefore the stimulus to multiplication lies in the action of the salivary glands.

The virus, as it seems, is not an organism and, therefore, it cannot be said to definitely possess incubation period, but this phenomenon can perhaps be explained on the assumption that the virus must multiply inside the insect before there is sufficient quantity to form an infective dose. It is true that the rate of multiplication of a virus inside the insect is affected by the latter's metabolism and that is the reason why there is such period of infective power that can be called incubation differing for some days.

In some species of aphids, particularly in the species that transmits the potato-virus, the insects are known to lose their power to infect healthy plants and must have recourse to a fresh supply of virus before it can infect again. It may be possible to explain this condition by the fact that the enzymes in the aphid juices may have a destructive effect upon the virus.

Consequently, from the foregoing evidence we can deduce the two theories acclaimed by most virus workers, namely an insect once infected can retain that infective power for the rest of its life and the alternative is that an insect accumulates somewhere in its body a given quantity of virus which gradually decreases unless access to a fresh source of infection is obtained.

I may also add that this decrease in the power of the virus within the insect or in other words the degree of virulence, can be accelerated to a greater degree if the insect can get access to the right kind of stimulus which is different from a fresh source of infection, but sought in a certain kind of plant juices.

From the previous discussion, one can clearly conclude that some obligate connection exists between the midges and the virus, but the nature of this connection is still to be settled and much remains to be learnt on this subject especially upon the question of the specificity of the particular insect for a particular disease. From the experiments on host transmission, we can finally exclude such insects like *Anopheles*, *Tabanus* and *Aedes* as agents for the transmission of horse-sickness.

I have previously mentioned that the virus is affected by environmental conditions but no experimental data can be obtained to throw evidence on the question of virus and virus bearing insect in relation to variations in temperature and humidity to the optimum and beyond that optimum. Henderson Smith claims that the temperature as well as the degree of alkalinity and acidity which destroy the protein in the host's body decreases in a likewise manner the degree of infectivity.

THE VIRUS, HOSTS AND PATHOGENITY

The disease is manifested in fever and a pulmonary œdema. In the subcutaneous form œdematous swellings develop under the skin, especially about the eyes.

The virus is very resistant and it can remain virulent for two years in septic blood 3 % carbolic acid, glycerin 5-10 % natrium taurocholicum do not kill it. The virus maintains itself in PH 5.9-10.00. Methylene blue destroys it.

Besides being transmissible to equines, it is artificially transmissible to dogs and goats. The blood of sick goats was infectious for goats and dogs but no longer for horses. The virus can be transmitted intra cerebrally to mice and evoke in them an encephalitis that could be transmitted to guinea pigs, rats and some other rodents (vide Alexander and Nieschulz). In rodents the virus is converted to a neurotrop modification; in horses the virus produces only a light fever reaction without manifestation of typical horse-sickness (Alexander, Du Toit). It is probably not neurotrop for horses.

« After surviving the sickness, horses develop a certain immunity. Relapses observed are perhaps to be explained by different virus stocks giving the same manifestations. The antigen structure of these stocks differ more quantitatively than qualitatively. A simple virus infection gives in neurotrop

virus only a serum that neutralizes the infection-stock, while several injections produce a polyvalent serum even with only one stock » (Alexander, 1935).

COSTROL MEASURES

(1) **Vaccination** : It is generally accepted that when man or animal has been the subject of an attack by an infectious disease, it frequently happens that a certain kind of natural immunity develops which prevents a recurrence of that disease for some time. In virus infection the natural immunity against a second attack is often very strong and for this reason it is considered by some authorities to be in a different category altogether from the immunity which is subsequent to bacterial diseases. There are of course some viruses which are exceptions to this rule such as influenza in man, foot and mouth disease in cattle, and the horse sickness we are discussing. The problem in this case is complicated by the existence of numerous strains of the viruses which do not immunises against each other.

The immunity which we speak of now is being built up in the body by the formation in the blood of a substance known as « antibody ». These antibodies have the power to neutralize the specific bacterium or virus which is known as the « antigen ». Therefore, the immunization of the animals by vaccination is an artificial process which involves the inoculation of the viruses after they have been inactivated by special methods that will retain their antigenic properties. The vaccine imported from South Africa proved to be successful in immunizing the Egyptian animals for a period of six months. This vaccine is now being prepared in Egypt by the veterinary department. It has been noticed that immunity reached its height in Egyptian animals three weeks after vaccination.

« The protective inoculation worked out by Theiler in which virus neutralizing serum and blood containing virus diluted with glycerin and carboic acid are used in the form of a simultaneous inoculation, has in spite of none too rare considerable losses of inoculating substance, nevertheless significant economic value. Practical experience with a virus transformed by animal transmission for protective inoculation are not available (Seiffert, 1944).

(2) With the development of regular air routes between Egypt and Africa, it is not unlikely that some infected midges might have been carried from a focus of infection to our country. To meet this danger precautions have been taken at the border line to treat the airplanes indiscriminately that arrive from countries where the disease is known to occur.

(3) Another possibility of the introduction of the disease into Egypt might be the introduction of diseased animals across our open southern fron-

tiers or very likely through the entry of an animal which apparently is sound but carries the disease as a natural reservoir. Therefore, strict quarantine is vital to ward off such diseased or suspected animals.

(4) Not much work has been done on the chemotherapy of the virus diseases, but some recent work has been done by internal administration of one of the most important sulphonamide compounds, namely the prontosil, against dog distemper and although some benefit has been claimed, it is worthy that this partial achievement may be inductive towards progressive work on the horse-sickness.

(5) For the variety of breeding places involved, it is necessary to determine for each species the most appropriate grounds on which they abound for instance, midges which flourish in mud and plant debris along the margins of fresh water streams or ponds, in such case the removal of vegetation, canalization and filling in low ground will be very helpful in checking the population and reducing their danger.

(6) In case of adult gnats there are two ways of tackling them, the first is by using a mixture of one part pyrethrum extract (concentrated), 20 parts lubricating oil, and 3 parts of 10 % DDT, and by means of a brush or rag apply to window screens. This mixture is reported to exclude the flies from the stables and remains effective for three weeks. The second method is to spray the animals with 2 % Fleming solution or with pyrethrum extract with oil 1.5 %. By this method we can kill any midges on the animals and more so afford them protection for 24 hours.

(7) Cutting or trimming of trees on the edges of streams and marshes so as to permit sunlight and thus the drying of accumulated decaying vegetation will affect a permanent reduction in the fly breeding grounds.

(8) Paris green and oil films have been found to give no visible effect on the larvae contrary to the control measures in mosquito. But a mixture of Panama oil (pine sap and creosote oil) and crude carbolic acid (9 parts to one part of the latter) will give a complete kill of the larvae in dilutions of 1-10.000 parts of salt water. In mosquito larvae, however, it gives a kill in much greater dilutions.

(9) Other methods such as the isolation of suspected animals, the placing of quarantine barriers between zones, and the burying of animals corpses are all measures of greater importance and need not to be overemphasized.

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2
Contribution to the knowledge
of the Biology
of *Thrips tabaci* Lind. in Egypt

[Thysanoptera]

(with 2 Plates, 8 Text-Figures, and 9 Tables)

by Dr. ABDEL AZIZ ALI EL-SAYED GHABN,
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I. INTRODUCTION

According to Willcocks (195), *Thrips tabaci* Lind. « although it is one of, if not quite the commonest thrips in Egypt, did not come to be looked on as a pest, a minor pest, of the cotton crop in its early stages until 1910 ». Since that year cotton seedlings were attacked and injured by this insect from time to time. Willcocks continued: « although thrips is present on most cotton crops every year, it appears that it is only in some years, quite occasionally in fact, that the insects are so numerous and the damage they do so severe and widespread that even the most unobservant are forced to notice them, or perhaps more correctly, realise that something is amiss with the cotton ».

Between 1928 and 1930, Priesner and the author while making a survey of the Thysanoptera in Egypt, found *Thrips tabaci* widespread on numerous host plants throughout the country. Priesner is of the opinion that this insect was introduced to Egypt long ago but naturally neither the date nor the means of introduction could be ascertained.

Until 1930, this thrips and the injury it caused was scarcely known to cultivators here, this injury, according to Willcocks, having been usually attributed to other pests such as aphids, springtails, cutworms, mole crickets, etc., which appear about the same time. Within recent years, *Thrips tabaci* has been recognized as a pest of increasing importance on cotton. The damage increased progressively and was not confined to any particular variety or locality. In spite of the different resistance of various cotton varieties to attack, and the variable degree of infestation in different districts, its seasonal occurrence on, and injury too, cotton seedlings became more distinct and regular, so that it has recently been regarded as one of the most serious cotton pests in Egypt. Apart from the direct injury to seedlings, the retardation of growth also increases attacks by *Prodenia litura* F. and *Platyedra gossypiella* Saund.

Before 1936, this insect had not been thoroughly studied in Egypt. Early in that year, the Entomological Section of the Ministry of Agriculture decided on a thorough investigation of the Biology and Control of the cotton thrips. This paper deals with the biology. A study of the control measures will be given in a later paper.

Acknowledgments

I take the opportunity to tender my gratitude and thanks to Mohamed Bey Zoheiry, Director, Entomological Section, Prof. Dr. Hermann Priesner, Entomological Expert, and to all my assistants and colleagues who have always been ready to give help and advice.

II. TECHNIQUE

In order to study the thrips in the egg-stage petri dishes 7.5 cms. in diameter and 2.5 cms. high were used. Each of these had a flange and neck on which muslin was secured with a rubber band to prevent the escape of larvae and to allow ventilation. Inside each dish a cotton leaf under the epidermis of which thrips eggs had been laid, was placed between two pieces of pressed and moderately wet cotton wool, 5 cms. diameter by 2.5 cms. thick. The cotton wool was kept moist by adding a few drops of water from time to time. By this method the cotton leaves remained fresh for ten or more days.

Test tubes 20 cms. long by 2.5 cms. width were used for breeding larvae. Each tube was filled to about one third of its length with water, and was then covered by a cork 5 mms. thick. The leaf petiole reached the water through a hole in the stopper, while the lamina remained in the air above the cork. The neck of the tube was plugged with cotton wool. Hatching larvae were carried to the breeding tubes with camel-hair brushes. The leaves in the breeding tubes were changed from time to time in order to supply the larvae with suitable food continuously. This same method was used for studying the oviposition of the females. By transferring the leaves to petri dishes every day, records were obtained of the number of eggs deposited and hatched every 24 hours.

In studying the prepupal and pupal stages, the full-grown larvae, together with some food, were transferred to test tubes similar to those used for breeding larvae. The bottom of these tubes contained sand or clay which was kept moist by dropping water from a pipette. A cork stopper was not required in these tubes, but as before, the necks were plugged with cotton wool.

III. MORPHOLOGY

The morphology of this species was repeatedly dealt with by various authors. I have to refer in this respect particularly to the more or less full descriptions given by Uzel (178), Hinds (77), Van Eecke (180b), Priesner (128), Fedorov (51b), and Speyer (163).

There is no need, therefore, to repeat all the details as to the morphology of this insect; it seems, however, to be useful to point out the differences of the stages of development of *Thrips tabaci* from one another, and from the similar species in this country with which larvae and adults might be confused, and to give exact illustrations which were not given before, and which show all details much better than does any description (Plates I and II).

As in all forms of the Family Thripidae to which *Thrips tabaci* belongs, it passes through several stages of development. They are as follows: 1. egg; 2. larva, 1st instar; 3. larva, 2nd instar; 4. prepupa; 5. pupa; 6 adult (male and female).

1. Egg

The egg does not show any peculiar characters. It is bean-shaped when contained in the body of the female (length 0.26 mm., width 0.12 mm.) but becomes elliptical in shape when it is embedded in the tissue of the host plant after oviposition.

Explanation of Plate I

Thrips tabaci Lind.

Fig. 1 : Larva, first stage, $\times 80$. — Fig. 2 : Larva, second stage, $\times 70$. — Fig. 3 : Prepupa, $\times 115$. — Fig. 4 : Pupa, $\times 100$. — Fig. 5 : Adult female, $\times 80$. — Fig. 6 : Cotton seedling, injured, half natural size.

The Biology of Thrips tabaci Lind. in Egypt

Plate I

Dr. Abdel Aziz Ali El-Sayed Ghabn



1



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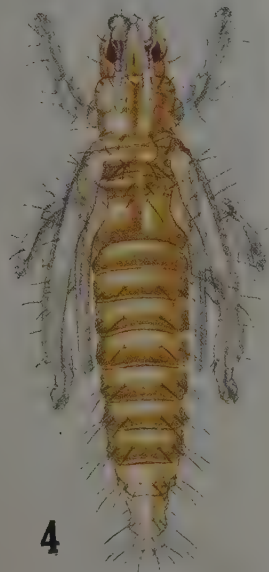
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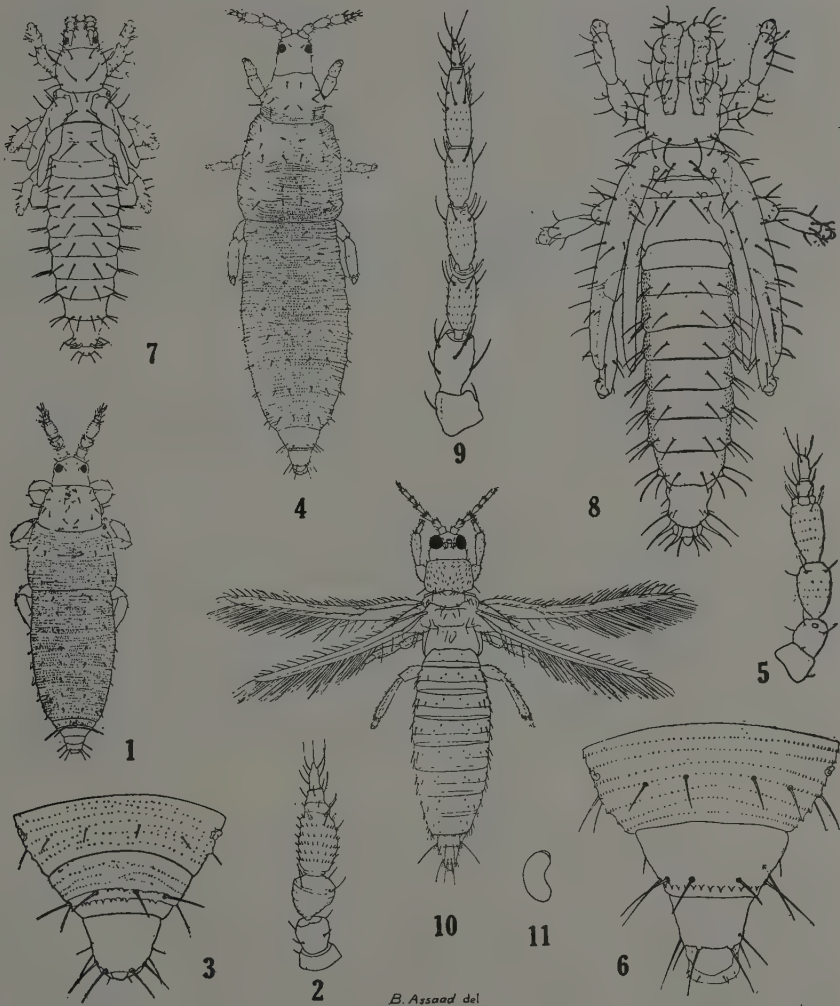
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B. Assaad del.

V. Siviter Smith & Co., Ltd.
Birmingham, England



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Thrips tabaci Lind.

Fig. 1 : Larva, first stage, $\times 60$. — Fig. 2: Larva, first stage, antenna, $\times 230$. — Fig. 3: Larva, first stage, terminal abdominal segments, $\times 230$. — Fig. 4 : Larva, second stage, $\times 60$. — Fig. 5 : Larva, second stage, antenna, $\times 230$. — Fig. 6 : Larva, second stage, terminal abdominal segments, $\times 230$. — Fig. 7 : Prepupa, $\times 45$. — Fig. 8 : Pupa, $\times 60$. — Fig. 9 : Adult female, antenna, $\times 230$. — Fig. 10 : Adult female total, $\times 45$. — Fig. 11 : Egg, $\times 30$.

2. Larva

The pale yellow larva differs from the adult by its more tender cuticle of the body which is set with comparatively short bristles and has a peculiar microsculpture, consisting of transversal rows of extremely fine tubercles, the eyes are much smaller and the antennae have simple (not forked) sense-cones; the wings, naturally, are wanting.

Differences of the two instars

The young larva (1st instar) is chiefly characterized by the short (top-shaped) third antennal joint and the pointed terminal (6th) joint, whilst in the second instar, the antennae are more slender, especially joint 3 longish, and the terminal joint rounded at tip.

In distinguishing the two instars, one should not rely on the shape or length of the body, as full-grown larvae of the first instar may be even larger and broader than newly moulted 2nd instar larvae, the size and shape of the body depending largely on the amount of adipose tissue.

3 and 4. Prepupa and Pupa

These two stages of development, differing from the larvae by the presence of wing-sheaths, are easily separated from each other: The prepupa has shorter wing-sheaths which hardly exceed in length the head and the prothorax together, whilst they are much longer in the pupa. The antennal sheaths are not extended over the prothorax in the prepupa while they cover about half the length of the prothorax in the pupa. Prepupa and pupa have four hyaline spines on the tip of the abdomen, and the body bristles are much longer in both, larva and adult as well.

5. Specific characters of the larvae of *Thrips tabaci*

To distinguish the larvae of *Thrips tabaci* from other Egyptian species of this genus or even from species of *Taeniothrips* or *Stenothrips*, is not an easy matter, even to the trained eye, but it may be said that of all the common forms the larva of *Thrips tabaci* has the shortest macrosetae; e.g. the lateral bristles of the prothorax (b.7 according to Priesner's nomenclature) measure about 20 μ . Another character is the lack of dark gray (chitinous) markings on the dorsum of the thorax, being prevalent in a number of otherwise similar forms of the Egyptian Fauna. In addition, the shape of the tiny elements of the microsculpture of the abdomen is peculiar, as it consists of pointed wartlets whilst in most of the other forms these elements of sculpture are larger and rounded.

6. Adult insect

Much easier it is to characterize the adult (female). As much as this species varies in colour (from pale yellow to grey brown) and in length (from 0.8 (segments contracted) to 1.2 mms. (segments distended)), it will always show the following chief characters : 7-jointed antennae, prothoracic and wing bristles comparatively short, no accessory setae on the sternites (i.e. except those on hind margin), and entire « comb » on tergite VIII, regularly four (4) (rarely 3) distal bristles on upper vein of fore wing. The 1st antennal joint is in *Thrips tabaci* always much paler than the 2nd.

All colour varieties described by Uzel (178) and Priesner (128) occur in Egypt, i.e. : f. *annulicornis* Uz., f. *irrorata* Pr., f. *nigricornis* Pr., f. *pulla* Uz., and f. *atricornis* Pr.

IV. BIOLOGY

1. The adult stage

Shepherd (156) was able to keep a few adults alive for 50 days and in one case he succeeded in keeping an adult alive for 58 days. The duration of the adult stage according to Fedorov (51a) is 20 to 25 days; Eddy and Clarke (45) 14 days; Sakimura (145a) 32.4 days; Franssen and Van Heuren (56) 19 days average and 25 days maximum; Watts (190) 18.33 days average.

In our experiments at Giza under laboratory conditions (see Table I) the author found the following : In the course of 7 generations, 1044 cases were examined between 28.7.37 and 7.1.38, at temperatures varying from 17.35° C. to 33.14° C. For these the average duration of the adult stage was 14.5 days with a maximum of 30 days and a minimum of 1 day.

2. The egg stage

Gurney (69) stated that the egg stage lasts 4-7 days; Mokrzecky (110) 5-7 days; Horsfall and Fenton (81) 3 days; Wardle and Simpson (185) 8 days; Mac Gill (98) 8 days; Fedorov (51a) 4-4.5 days; Eddy and Clarke (45) about 5 days; Watts (190) 4-5.3 days; Sakimura (145a) 3.6-6.5 days, and 6.1 days for the preoviposition.

The results of the authors experiments are shown in Table II. Between 27.7.37 and 28.11.37 of the 6 generations and 1332 cases examined, the average duration from the emergence of the adult to egg-hatching was 6.99 days with a maximum of 10 days and a minimum of 5 days. Temperature 18.33° C.

The number of eggs from each female that actually hatched is according to Mac Gill (98) 10-20; and according to Hinds (77) 30 to 40 % of

TABLE I
Emergence, oviposition, and longevity of adult

GENERATIONS		I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938		28.7-4.8	22.8-31.8	17.9-26.9	14.10-22.10	10.11-17.11	7.12-13.12	2.1-7.1	28.7-7.1
Total emerging females.		90	162	252	261	189	72	18	1044
Total ovipositing females.		90	153	198	180	108	36	—	765
Percentage.		100	94.45	78.57	68.97	57.14	50	—	73.28
Duration in days	Minimum.	1	4	8	13	18	22	25	1
	Maximum.	12	14	17	21	25	28	30	30
	Total.	624	1403	2891	3894	3620	1712	525	14669
	Average.	6.93	8.66	11.47	14.92	19.15	23.78	29.14	14.05
Temperature in °C.	Mean.	27.14	26.17	25.13	24.12	23.26	22.18	21.35	25.25
	Minimum.	21.14	20.67	19.63	19.12	18.76	18.18	17.35	17.35
	Maximum.	33.14	31.67	30.63	29.14	27.76	26.18	25.35	33.14

TABLE II
Pre-oviposition and incubation period

GENERATIONS		I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938		27.7-5.8	5.8-27.8	14.8-18.9	23.8-11.10	2.9-3.11	17.9-9.17	—	27.7-28.11
Hatched eggs.		180	297	360	306	144	45	—	1332
Duration in days	Minimum.	5	5	5	6	7	7	—	5
	Maximum.	9	9	9	10	10	10	—	10
	Total.	1098	1908	2452	2222	1151	378	—	9209
	Average.	6.100	6.423	6.810	7.260	7.996	8.400	—	6.988
Temperature in °C.	Mean.	27.14	26.17	25.13	24.12	23.26	22.18	—	25.66
	Minimum.	21.14	20.67	19.63	19.12	18.76	18.18	—	18.18
	Maximum.	33.14	31.67	30.63	29.12	27.76	26.18	—	33.14

TABLE III
Number of eggs per female

GENERATIONS	I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938	27.7- 5.8	5.8- 27.8	14.8- 18.9	23.8- 11.10	2.9- 3.11	17.9- 28.11	—	27.7- 28.11
Deposited eggs	Minimum	3	3	3	3	3	—	3
	Maximum	22	20	18	16	15	—	22
	Total	430	717	903	797	463	—	3459
	Average	4.77	4.68	4.56	4.43	4.29	—	4.52
Hatched eggs	Minimum	—	1	1	1	1	—	1
	Maximum	9	8	7	6	5	—	9
	Total	180	297	360	306	144	—	1332
	Average	2	1.94	1.82	1.70	1.33	—	1.74
Percentage of hatched eggs to deposited eggs	41.86	41.42	39.87	38.39	31.10	30.20	—	38.51
Temperature in °C.	Mean	27.14	26.17	25.13	24.12	23.26	—	26.16
	Minimum	21.14	20.67	19.63	19.12	18.76	—	18.18
	Maximum	33.14	31.67	30.63	29.12	27.76	—	33.14

TABLE IV
The first larval stage

GENERATIONS		I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938		1.8-9.8	10.8-31.8	19.8-22.9	29.8-15.10	9.9-7.11	24.9-30.11	—	1.8-30.11
Cases	First stage into	180	297	360	306	144	45	—	1332
	Second stage	171	270	297	234	99	27	—	1098
Mortality %		5	9.99	17.50	23.53	31.25	40	—	17.57
Duration in days	Minimum	1	1	1	1	2	2	—	1
	Maximum	4	4	4	4	4	4	—	4
	Total	342	592	686	561	255	81	—	2517
	Average	2	2.194	2.310	2.396	2.575	3	—	2.342
Temperature in °C.	Mean	27.14	26.17	25.13	24.12	23.26	22.18	—	26.16
	Minimum	21.14	20.67	19.63	19.12	18.76	18.18	—	18.18
	Maximum	33.14	31.67	30.63	29.12	27.76	26.18	—	33.14

TABLE V
The second larval stage

GENERATIONS		I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938		2.8-13.8	11.8-4.9	20.8-26.9	30.8-19.10	11.9-11.11	26.9-4.12	—	2.8-4.12
Cases	Second stage into	171	270	297	234	99	27	—	1008
	Prepupal stage	162	252	261	189	72	18	—	954
Mortality %		5.26	6.66	12.12	19.23	27.27	33.33	—	13.11
Duration in days	Minimum	1	1	1	1	2	2	—	1
	Maximum	4	4	4	4	4	4	—	4
	Total	351	550	623	495	207	63	—	2289
	Average	2.170	2.181	2.387	2.621	2.873	3.500	—	2.399
Temperature in °C.	Mean	27.14	26.17	25.13	24.12	23.26	22.18	—	26.16
	Minimum	21.14	20.67	19.63	19.12	18.76	18.18	—	18.18
	Maximum	33.14	31.67	30.63	29.12	27.76	26.18	—	33.14

TABLE VI
The prepupal stage

GENERATIONS		I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938		3.8-15.8	12.8-6.9	21.8-28.9	31.8-21.10	13.9-13.11	28.9-6.12	—	3.8-6.12
Cases	Prepupal stage into	162	252	261	189	72	18	—	954
	Pupal stage	162	252	261	189	72	18	—	954
Mortality %		0	0	0	0	0	0	—	0
Duration in days	Minimum	1	1	1	1	1	2	—	1
	Maximum	2	2	2	2	2	2	—	2
	Total	198	343	409	323	135	36	—	1442
	Average	1.220	1.360	1.567	1.711	1.873	2	—	1.505
Temperature in °C.	Mean	27.14	26.17	25.13	24.12	23.26	22.18	—	26.16
	Minimum	21.14	20.67	19.63	19.12	18.76	18.18	—	18.18
	Maximum	33.14	31.67	30.63	29.12	27.76	26.18	—	33.14

TABLE VII
The pupal stage

GENERATIONS		I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938		4.8-18.8	13.8-9.9	22.8-1.10	1.9-24.10	15.9-16.11	1.10-9.12	—	4.8-9.12
Cases	Pupal stage into	162	252	261	189	72	18	—	954
	Adult stage	162	252	261	189	72	18	—	954
Mortality %		0	0	0	0	0	0	—	0
Duration in days	Minimum	1	1	1	1	2	3	—	1
	Maximum	3	3	3	3	3	3	—	3
	Total	278	504	571	484	198	54	—	2089
	Average	1.720	2.001	2.187	2.561	2.753	3	—	2.190
Temperature in °C.	Mean	27.14	26.17	25.13	24.12	23.26	22.18	—	26.16
	Minimum	21.14	20.67	19.63	19.12	18.76	18.18	—	18.18
	Maximum	33.14	31.67	30.63	29.12	27.76	26.18	—	33.14

TABLE VIII

The life-cycle

GENERATIONS		I	II	III	IV	V	VI	VII	TOTAL
PERIOD 1937-1938		27.7-18.8	5.8-9.9	14.8-1.10	23.8-24.10	2.9-16.11	17.9-9.12	—	27.7-9.12
Cases	Eggs into	180	297	360	306	144	45	—	1332
	Adult stage	162	252	261	189	72	18	—	954
Mortality %		10	15.15	27.05	28.23	50	60	—	28.38
Duration in days	Minimum	9	9	9	10	15	17	—	9
	Maximum	22	22	22	23	23	23	—	23
	Total	—	—	—	—	—	—	—	—
	Average	13.21	14.16	15.26	16.55	18.07	19.90	—	15.42
Temperature in °C.	Mean	27.14	26.17	25.13	24.12	23.26	22.18	—	26.16
	Minimum	21.14	20.67	19.63	19.12	18.76	18.18	—	18.18
	Maximum	33.14	31.67	30.63	29.12	27.76	26.18	—	33.14

the total number of eggs laid in the case of *Anaphothrips obscurus* (Muell.). Mac Gill believes that the hatching percentage of the eggs of *Anaphothrips* is similar to that of *Thrips tabaci*.

According to Eddy and Clarke (45) the average number of eggs from each female hatching is 14, and these are laid within 8 days. Sakimura (145a) stated that the average number was 37.24 in Hawaii, and from 23-119 in Japan; Fransen and Van Heurn (56) 84, and Watts (190) 44.25.

Of the 1044 females examined at Giza, only 765 laid eggs (73.28 %). Of the 3459 total number of eggs laid only 1332 hatched (38.51 %). The average number of eggs hatched (from each female) was 1.74 with a maximum of 9 eggs and a minimum of 1 egg. To obtain these figures, 6 generations were examined between 27.7.37 and 28.11.37 when the temperature varied from 18 to 33°C. (see Table III).

3. The larval stage

There are two larval instars, as previously mentioned. Mokrzecki (109) reported that the average duration of both instars is 20 days; according to Fedorov (51) it is 8 days; Boerne (18a and 18b) 7 days; Mac Gill (98) 10-14 days; Vinson (183) 10 days; Sakimura (145a) 4.57 days; Eddy and Clarke (45) 2-3 days for each instar; Sakimura (145b) 6.4-13.5 days for both instars.

In our experiment with the 1st instar, 1098 larvae survived out of 1332 (82.43 %). The average duration of this stage was 2.34 days, with a maximum of 4 days and a minimum of 1 day. Temperature 18-33°C. Time, between 1.8.37 and 30.11.37 (Table IV).

Only 954 out of these 1098 larvae completed the 2nd instar (86.89 %). The average duration for this stage is 2.4 days, with a maximum of 4 days, and a minimum of 1 day. Temperature 18-33°C., in the time between 2.8.37 and 4.12.37 (Table V).

4. Prepupal stage

The prepupal stage lasts, according to Wardle and Simpson (185) 1-2 days; Eddy and Clarke (45) 1.5 days; Sakimura (145a) 1.54 days; Sakimura (145b) 1.2-2.8 days. In the 954 prepupae examined, the average duration of this stage was 1.51 days with a maximum of 2 days and a minimum of 1 day. Temperature 18-33°C in the time between 3.8.37 and 6.12.37 (Table VI).

5. Pupal stage

The pupal stage lasts according to Wardle and Simpson (185)

from 4 to 7 days; Eddy and Clarke (45) 3 days on an average; Sakimura (145a) 3.3 days; Sakimura (145b) 2.2-6.2 days; Fedorov (51a and 51b) found that the prepupal and pupal stages together lasted 2.5-3.5 days; while Vinson (183) said that both stages took 4-5 days.

In our experiments where 954 pupae were examined, the average duration of this stage was 2.19 days and a minimum of 1 day. Temperature 18-33°C. in the time between 4.8.37 and 9.12.37 (Table VII).

6. Life cycle

Vuillet (182) mentions that Lindeman had estimated the length of the whole life cycle to be about 47 days; Quaintance (129) 17 days average; Gurney (69) 16-21 days; Kinsey (90) 21 days; Horsfall and Fenton (81) 11 days, on an average, with 16 days maximum; Wardle and Simpson (185) 23 days av.; Fedorov (51a and 51b) 14.5-16 days; Vinson (183) 17-20 days; Eddy and Clarke (45) 14 days av.; Sakimura (145a) 19.54 days; Research Institute of India (2) 17-18 days; Sakimura (145b) 14.5-29.1 days; Franseen and Van Heurn (56) 9 days av. with 12 days maximum; Watts 16.3 days av.; Willcocks (195) 21 days.

In the six generations examined between 27.7.37 and 9.12.37 under temperatures varying from 18-33°C., the whole life cycle lasted 15.424 days on an average, with a maximum of 23 days and a minimum of 9 days (Table VIII).

There was an apparent overlapping of the generations. In many cases, larvae of one generation could be found side by side with those of a previous generation

V. HABITS

1. Reproduction

All the authors agree that parthenogenesis is the commonest way of reproduction in *Thrips tabaci*. Sexual reproduction occurs sometimes but owing to the general preponderance of females over males it is a very rare phenomenon. According to Mac Gill (98) the ration of the male to the female is 1:3000.

In Egypt, neither Willcocks, nor Priesner or the author have ever observed copulation of *Thrips tabaci*. The insect collection of the Ministry of Agriculture contains only a few male specimens found in Egypt, some of these were collected by Priesner and some by Willcocks. Priesner observed the males particularly on ears of Gramineae in bloom (*Triticum*, *Hordeum*, *Polypogon monspeliensis*) and in flowers of flax (*Linum usitatissimum*). All these males were collected in March and April.

2. Oviposition

The ovipositor is situated between the 8th and 9th abdominal segments. It is armoured with a knife-shaped apparatus by means of which the female cuts through the epidermis of the host plant leaf, etc., to deposit eggs singly into the underlying tissues.

3. Larval stages

As in the case of the adult, the larva feeds on leaves, buds, flowers, fruits or on any other part of the plant suitable for sucking. Mokrzecky (110), Willcocks (195) and some other investigators believe that the larvae cause more injury to crops than the adults; while Sommerville (168) and some others attribute most of the damage to the adult. From my experience both in field and laboratory, I am inclined to agree with the former opinion.

4 and 5. Prepupal and pupal stages

The full-grown larva goes down into the soil before moulting into the prepupal and pupal stages. It usually descends to a depth of 3-5 cms. but may sometimes go deeper and is thus saved from death by flood or heavy rain. In some cases the moulting to the prepupal and pupal stages can take place outside the soil, if the larvae are prevented from reaching it. The prepupae and pupae do not feed, nor do they move about unless they are touched or sense the approach of danger.

6. Hibernation

Most of the investigators believe that this insect passes the winter in the adult stage. Vinson (183) reports that it hibernates as pupa inside onion bulbs. The author believes that in Egypt hibernation takes place chiefly in the adult stage, though larvae may occasionally be found late in December and early in March. Such occasions are always preceded by warm weather which continues for several days. According to Mac Gill (102) the critical low temperature of *Thrips tabaci* is 8° C. In Egypt, the minimum temperature in winter is about this degree. When the temperature rises above this average and keeps on for enough time, development sets in and larvae appear on such occasions. The larvae die when the temperature returns normal. In January, the coldest month, the only stage found was the adult. Hibernating adults are sluggish in their movements and dark in colour (ff. *pulla* and *atricornis*), whilst those of the spring and summer generations are fairly active in their movements and are from pale yellow to brownish yellow in colour. Willcocks (195) stated that the insect is active through-

out the whole year. The hibernating adult passes the winter on weeds and grasses in the fields or near the canals or it may live on some crops growing at this time. When spring returns, it migrates to any new crop it may prefer.

7. Generations

Breeding experiments on this insect were started in August 1937 and continued till December of that year. The adults of the last generation to emerge did not lay eggs and later died. Because of this, it was impossible to calculate the exact number of generations per year under laboratory conditions.

The number of complete generations in the 4-5 months (August to December) was six, hibernation taking place by the adults of the 7th generation. Hibernation continued for about four months, i.e. until March of the following year, when larvae of the 1st generation in the spring began to appear. Between March and August, the author estimated that there were eight overlapping generations, thus bringing the total number of generations to about 15 per year. Weekly counts of thrips on cotton from early March to the end of May for two successive years gave support to the above estimate.

8. Migration

(a) Active migration

Thrips tabaci may migrate from one place to another in the same field, or to other plants much farther away. The migration is either purely voluntary or else due to other factors, e.g. :

(1) Bourne (18a and 18b) believes that it migrates from set onions to seed-onions when the former are harvested. At that time the insect is very active and numerous, and would soon die as the set onions ripen. At this time the young seed-onions have emerged, and are generally liable to severe attack by migratory thrips. The dry condition of the original host plant forces the insect to migrate.

(2) Fedorov (51a and 51b) agrees with Bourne's view but adds that migration starts when the crop begins to ripen and increases progressively when the time of harvesting approaches. The age of the plant is therefore an important factor in migration. He suggests that there is an indirect relation between migration and humidity as well as a direct relation between humidity and ripening.

(3) Carter (32) states that *Thrips tabaci* is not distributed by wind action alone but mainly because it prefers the plant to which it migrates.

Since migration is the chief means of distribution of this pest, it is of great economic importance.

(b) Passive distribution

It need not be discussed that wind plays a great role in the distribution of the thrips.

9. Response to tropisms

(a) Geotropic response

Laboratory experiments were carried out to determine the geotropic response of the onion thrips. Two glass cylinders, 60 by 1.5 cms. each, kept in a vertical position were plugged at each end with cotton. The first glass cylinder was used for testing the adults, the second one for the larvae. 70 individuals of both instars were examined. The results of this test are shown in the following Table.

PERCENTAGE OF ADULTS	PERCENTAGE OF LARVAE	TIME (IN MINUTES) OF MIGRATION UPWARDS TO THE UPPER END
42.86	3.19	15
87.50	8.51	30
98.22	30.85	60
—	48.93	90
—	69.14	120
—	90.42	150

In one hour 98.22 % of the adults and only 30.85 % of the larvae had congregated at the upper end of the glass cylinder. In two and a half hours 90.42 % of the larvae had reached the upper limits. 1.78 % of the adults and 9.57 % of the larvae remained around the lower cotton plug for more than six hours. It is thus obvious that *Thrips tabaci* is for the most part negatively geotropic, but the larvae to a lesser degree than the adults.

(b) Phototropic response

Wardle and Simpson (185) write : « Both adults and larvae are negatively phototropic... ». In addition to this statement we could prove by some laboratory experiments the following :

(1) When the darkened tube used in the experiment was placed in a horizontal position, the rate of the travel of thrips in opposite direction to the light was not influenced by the geotropic stimulus.

(2) When the same tube was hung vertically and the insects were introduced at its darkened lower end, they remained at the bottom but restless-

ness and a tendency to yield to the negative geotropic stimulus was observed. Although both tropisms in this case were acting in opposite directions yet the negative phototropic stimulus had shown a greater effect than the negative geotropic one.

(3) When the insects were introduced at the lightened end of the vertically suspended tube, the rate of travel of the insects as to yield to both negative geotropic and phototropic stimuli, was comparatively increased with regard to that rate in a horizontal position of the glass cylinder. Both tropisms were acting in the same direction.

(4) The tendency to phototropism is more pronounced among adults.

(c) Thigmotropic response

Thrips tabaci has shown positive thigmotropism in the adult, larval, prepupal and pupal stages. They seek the available closely protected quarters on any part of the host plant. The factors influencing a tendency toward positive thigmotropism are not yet illuminated. Watts (190) believes that moulting of immature stages may in some way be connected with this response. Positive thigmotropism plays in fact an important role in protecting the insects against their natural enemies.

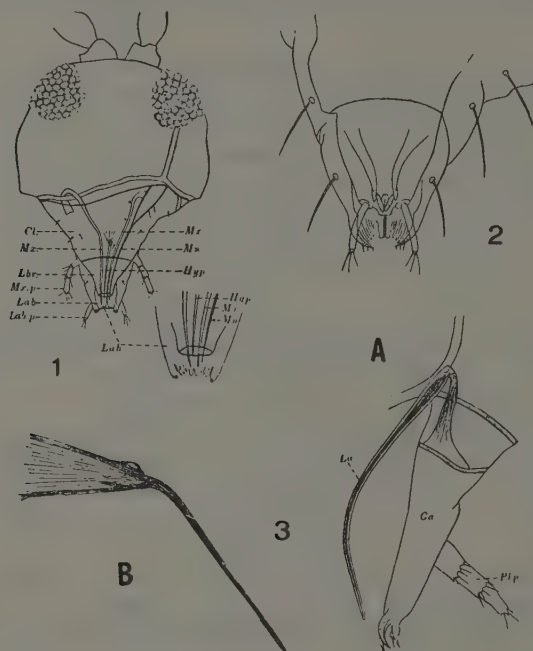
10. Feeding

The mouth-parts of the Thysanoptera have been carefully studied by many entomologists among whom were the following: Jordan (89), Garman (60), Bohls (14), Uzel (178), Buffa (27), Hinds (77), Boerner (13), Peterson (125), Priesner (128), and Reyne (133a).

The mouth represents an inverted cone the base of which is attached to the head. This cone is bent posteriorly below the head so that its axis forms an angle of about 45° with that of the body. The mouth-cone is composed of a labrum, a pair of mandibles of which the right element has practically disappeared, a pair of maxillae and a labium. The clypeus is situated on the anterior part of the cone above the labrum and is separated from the latter by a membrane. Both clypeus and labrum are asymmetrical. The sides of the cone are triangular in shape, and represent the galeae of the maxillae, each of which bears a three-jointed palpus. The triangularly shaped labium on the posterior face of the cone has a pair of two-jointed labial palpi at its distal ends. The labium is longer than the labrum or maxillae and projects beyond them. The maxillae and labrum have hook-like structures which enable the insect to fasten its mouth on the plant.

The piercing organ of the mouth chiefly consists of three stylets or lancets, i.e. one paired and one single, on the left side. Reyne (133a) believes that the paired stylets represent the laciniae of the maxillae, the

single left one the mandible. All these organs are strongly modified to suit the mode of feeding.



Thrips tabaci Lind.

Fig. 1 : Head of female (Cl, clypeus; Hyp, hypopharynx; Lab, labius; Lab.P, labial palps; Labr, labrum; Mn, mandible; Max, maxilla; Max.P, maxillary palps), $\times 205$. — Fig. 2 : Labium, $\times 500$. — Fig. 3 : (A) Maxilla, left (Ga, galea; La, lacinia; Plp, palp); (B) Mandible, $\times 500$. [after Wordle and Simpson, *Annals Applied Biol.*, XIV, pp. 513-527, 1927].

Wardle and Simpson (185) carried out some interesting research on the mouth parts of the Thysanoptera and explained the function of each organ of these parts. It is interesting to record the various opinions held in this respect : Horton (83) recorded that the insect pierces the tissue and sucks the contents of the cells, thereby causing destruction of the cell-walls. Russell (141) stated that thrips pierces the épidermis and rasps away the underlying tissues. Bedford (11) stated that the insect rasps away the leaf-tissues and sucks up the sap which is thus set free. Cameron and Treherne (30) believed that thrips pierces the vegetative tissue with the stylets and sucks up the plant juices thus liberated.

By cutting sections of infested leaves, Wardle and Simpson (185) proved that the insect neither pierces nor rasps but cuts through the epidermis with its mandible by means of a certain motion which is accompanied by a slight rocking of the head. In most cases the mandible is only able to cut or tear the outer walls of the epidermic cells. The inner cell walls and those of the underlying cells are cut by the long maxillae with a similar movement of the head. There is no evidence that feeding occurs through the stomata of the leaf. Chlorophyll is absorbed during the feeding operation which indicates that the cell walls are pierced.

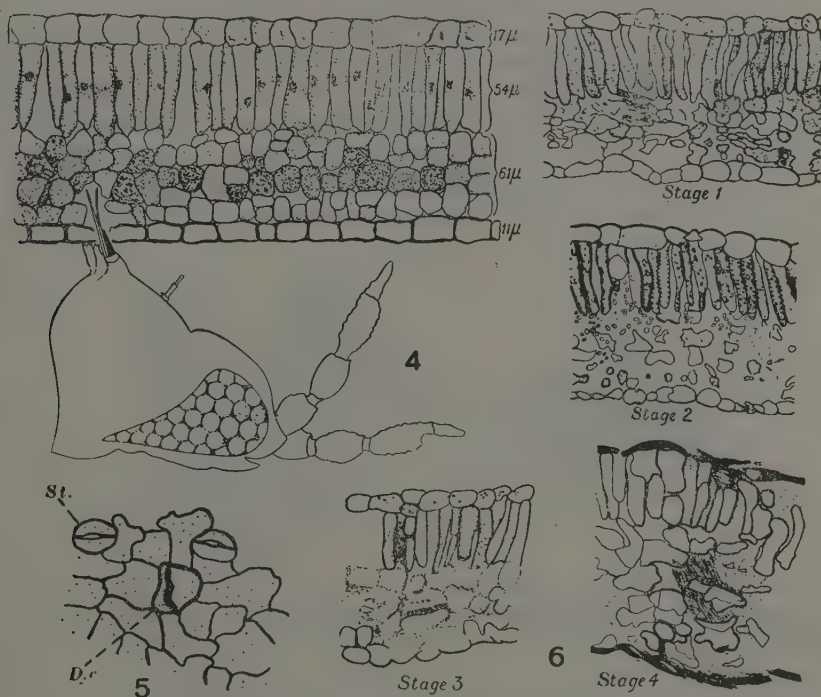


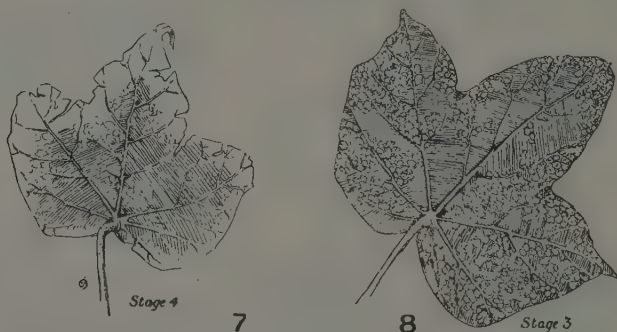
Fig. 4 : Diagram of the head of a feeding Thrips to indicate its size relative to the leaf tissue and the depth to which maxillae and mandible are inserted (greatly enlarged). — Fig. 5 : Portion of epidermis from lower surface of a cotton leaf to show the appearance of a cell gashed by a thrips (*D.c.*, damaged cell; *St.*, stomata), greatly enlarged. — Fig. 6 : Histological appearance of the four stages of thrips damage to cotton leaf (greatly enlarged). [after Wardle and Simpson, *Annals Applied Biol.*, XIV, pp. 513-527, 1927].

The thrips prefer to feed on the lower surface of the leaves, not to escape the light as was formerly thought but because the epidermis there is usually not so thick as that of the upper surface. In plants which have

both upper and lower epidermis cells of equal thickness, the infestation of each surface is about the same. There are even cases where the upper surface is preferable to the lower because of the dense mat of fine hairs on the latter. When the hairs are far apart they do not hinder the feeding operation; as for instance, the leaves of American and Indian cotton are more glabrous than those of the Egyptian cotton and yet the former varieties are more susceptible to thrips attack. Feeding is not confined to the leaves but may extend to buds, stems, twigs, blossoms, flowers or fruit, i.e. any vegetative part of the plant suitable for the feeding operation.

VI. INJURY

The damage done to plants as a result of thrips attack depends upon the stage of the attacking insect, as well as on the variety, age and morphological structure of the host plants. In addition, the ecological factors exert an influence on the host plant as well as on the insect and the damage caused. Some investigators have proved that the susceptibility to injury and the amount of damage done by thrips to its host plant, are directly related



Figs. 7 and 8 : Leaves of Sakellaridis cotton showing damage in two different stages (half natural size) [after Wordle and Simpson, *Annals Applied Biol.*, XIV, pp. 513-527, 1927].

to the thickness of the cell walls in different species, varieties, and even individuals of the same variety. Wardle and Simpson (185) by examining leaf sections concluded that the average thickness of a cotton leaf is $143\ \mu$, the upper epidermis being $17\ \mu$ and the lower $11\ \mu$. This difference in thickness between the upper and lower epidermis explains why the insect prefers the latter. Beneath the upper epidermis are situated the palisade cells, then follow the mesophyll layers, followed by the lower epidermis. The palisade and mesophyll layers have an average thickness of $54\ \mu$ and $61\ \mu$, respectively. The compactness of the mesophyll tissue varies in diffe-

rent varieties of cotton and appears to be affected by the intensity of light to which the leaf is subjected.

The mandibular stylet can be inserted through the epidermis for a distance of 11 μ beyond the mouth-rim, but the maxillary stylets can be extended 27 μ beyond the mouth-rim, bringing them into the tissue below the epidermis. It is not yet confirmed whether the insect uses the mandible in the same manner as the maxillae.

The first sign of injury are small silvery patches on the infested leaves. The thrips remove the sap from the cells beneath the epidermis and the space is then occupied by large bubbles which reflect the light and give the injured parts a silvery appearance. The tissue below the epidermis dries up and becomes brown. The brown patches gradually increase in size and become scattered all over the leaf as the infestation progresses. Finally the brown patches coalesce, causing the death of the leaf.

Each time the insect feeds, it tears the wall of one or more epidermic cells, as well as the walls of one or more cells of the underlying tissue. When the sap has been drained from the latter, the thrips withdraws its mouth-parts to go and feed elsewhere. This feeding operation may be repeated several times on one leaf or one plant or on different plants according to the stage of the feeding insect.

Eddy and Clarke (45) believe that a thrips attack on cotton seedlings causes malformation of the cotyledons and retardation of growth. Sometimes the terminal buds are destroyed, but their place is soon taken by actively growing lateral buds. The leaves may be injured in such a way as to cause slight curling of the lateral margins.

Sloan (157) recorded that thrips may destroy the terminal buds, thereby causing the cotyledons to grow more actively and to become fleshy and broad.

Willcocks (195) stated that some seedlings which have lost their cotyledons through thrips attack, are able to produce new leaves, either on the main stem, if the terminal buds are uninjured, or on the lateral branches, if the terminal buds are destroyed.

Pearson (122), in describing the damage done by thrips to the flowers both by feeding and oviposition, states that the insect feeds on the pedicel, sepals, petals; stamens and stigmas, and causes great damage. Attack on the stigma makes pollination and fertilisation of the ovules impossible, while attack on the stamens causes them to shrivel and die. The flower, however, is only injured when it is young. When it is in full bloom, the insect is unable to puncture the hard cell walls of the anthers and the ovary.

Damage to other parts of the flower, caused by the characteristic tearing and sucking may lead to cessation of growth of the infested part. As the

uninfested parts continue to grow, the flower soon assumes a distorted appearance.

Pearson is of the opinion that oviposition adds to the damage done by feeding especially when eggs are deposited near the feeding places. He noticed that the females may lay up to three eggs in the flower head without sterilizing the latter, especially when it is well advanced in growth. If oviposition takes place after fertilisation of the ovules, the latter will not be injured, provided the pedicel of the flower has not already been damaged by the feeding operation.

Speyer (164) states that the female deposits her eggs under the surface tissues of the petals after the latter have opened, but before they have opened, eggs are laid in the calyx. He also states that a single female may injure as many as 32 petals of carnations before the flowers are ready to be marketed.

According to Wardle and Simpson (185) the saliva of thrips has no toxic effect on the plant tissues, or juices.

Apart from direct damage to the host plant, the insect causes indirect injury. It has been proved that *Thrips tabaci* is a vector of several virus diseases, e.g. the so called « fig decaying disease » (Hansen (72)), mosaic disease of beet and spinach (Boming (15.)), and mosaic disease of tomato (Cleveland (38)).

Other investigators have proved that this insect is also a vector of yellow spot disease of pine-apple, spot wilt disease of tomato and streak disease of peas. These three diseases are probably caused by the same virus or by closely related varieties of the same sort of virus. Observations and experimental tests showed that a clean *Thrips tabaci*, if allowed to feed on infected *Emilia sagittata* can transfer the virus of : (a) yellow spot disease of pine-apple ; (b) spot wilt disease of tomato ; and (c) streak disease of peas.

These three diseases are apparently caused by a virus arising from a single source of infestation. This theory is strengthened by the fact that the symptoms of the three diseases are identical.

Amongst those who worked on this subject are Illingworth (84), Smith (158), Linford (94 and 95), Sakimura (145a), Hodson (78), Samuel and Bald (150), Gardner, Tomkins and Whipple (59), Smith (159), Bailey (7), Carter (31), and Whipple (191).

They succeeded in using *Thrips tabaci* as a vector of the virus diseases of many plants, such as pine-apple, tomato, tobacco, peas, *Datura*, *Dahlia*, *Calla*, *Emilia sonchifolia* (*sagittata*), *Narcissus*, *Solanum capsicastrum*, etc.. Most of them considered the *Emilia* as the chief source of virus infection for these plants, as they are favourable hosts of *Thrips tabaci*.

Chamberlain and Taylor (35) proved that *Thrips tabaci* is a vector of spot wilt disease, both in the adult and larval stages.

Speyer, Read and Orchard (165) contradict this, stating that only the adult stage is capable of transferring the disease.

Semenov (153) states that in addition to be a vector of virus diseases this insect also transfers *Bacterium tabacum* to the tobacco plant, thus causing severe leaf injury.

Wilkinson (194) believes that the brown spots appearing on flowers infested by *Thrips tabaci* are caused by the fungus *Alternaria gossypina*. These spots spread rapidly if the temperature and humidity are high. By cutting the epidermis and the underlying tissues the insect undoubtedly exposes the host to fungal and bacterial attack through these wounds.

Furthermore, the author showed (62) that a thrips attack on cotton seedlings caused a heavier infestation of *Prodenia litura*. This is due to the fact that a thrips attack weakens the seedlings and retards their growth, thereby making the plants more liable to a heavy infestation by the cotton leaf-worm. A heavy infestation of cotton leaf-worm causes further delay in growth and results in heavy infestations by the pink bollworm, *Platyedra gossypiella*.

A paper on the relation between thrips attack of cotton seedlings and infestation by the pink bollworm will be issued presently.

VII. THE ECOLOGICAL FACTORS

This section deals with the effect of the ecological factors on the life of *Thrips tabaci*, under the following headings : (1) climatic factors, (2) soil, and (3) natural enemies.

1. Climatic factors

Temperature and humidity are very important factors in the life of any organism. Of lesser importance are factors such as rain, cold winds, food, etc.

Mac Gill (98, 101 and 102) studied the influence of temperature and humidity on this insect and obtained very interesting results. The above author concluded that the thermovital zone of this insect is confined between 8°C minimum and 38°C maximum, the optimum temperature being 27°C.

According to Parker (121) the duration of the life cycle of an insect bred under constant temperature is longer than that of another bred in a range of temperature the average of which is equal to that constant temperature.

Mac Gill (98, 101 and 102) stated that the relative humidity has no marked effect on the duration of the life cycle of *Thrips tabaci*, but as

regards the mortality, the life cycle of this insect cannot be completed at high temperature unless the relative humidity is at least 70 %.

This study by Mac Gill explains the different data reported by many investigators on the duration of the different stages, as well as of the whole life cycle of *Thrips tabaci*. The main reason for these differences is that the insect was studied in different localities and in different seasons. If we study and compare the various results obtained, we come to the conclusion that the data obtained under the same climatic conditions are almost identical, while still agreeing with the figures in Mac Gill's graphs of life duration.

Our own results agree in general with those of Mac Gill as regards duration of the different stages as well as of the whole life cycle of this insect. There are, however, considerable differences between our mortality percentages and those found by Mac Gill under similar conditions.

In our experiments, the mortality for each of the first and second larval instars at 27°C average was about 5%. This gradually increased as the temperature decreased till at 22°C. average, it became 40 % for the 1st instar and 33 % for the 2nd instar, making a total of 60 % for both instars. The average mortality of six successive generations between 22 and 27°C. average was 17.5 % for the 1st instar, and 13 % for the 2nd instar making an average total of 28 % for both instars.

According to Mac Gill's graphs, the average mortality between 7°C. and 46°C. was about 87 % but between 22-27°C. it was about 77 %. The great difference between 28 % mortality in our experiments and 77 % in Mac Gill's graphs under similar conditions leads me to suppose that some unknown factor may have caused such high mortality in the latter's experiments.

Znoiko (197) states that the intensity of the population depends on the relative humidity of the atmosphere and that it increases or decreases as the relative humidity does.

Vuillet (182) believed that the relative humidity of the atmosphere is not in itself unsuitable to thrips, but by weakening the plant it renders the latter liable to infestation.

Rain is also an important factor affecting thrips. Most of the workers agree that heavy rain decreases the thrips population, while drought helps it to spread. This theory is supported by Vuillet (182), Williams (196), Horsfall and Fenton (81), Van Heurn (181), Ogilvie (117), Vinson (183), Illingworth (84), Franseen and Heurn (56), Harris and Drake (73a).

Harris and Drake (73a) state that cold storms generally kill the

thrips, because in such cases the temperature usually falls below the critical low temperature of the insect.

Wind may act as a means of distribution and helps migration of the insect. Carter (32) however, states that the chief cause of migration from one plant to another is the attraction of more favourable food (see p. 137).

In Egypt, temperature and humidity are the most important factors affecting *Thrips tabaci*. In winter (Table IX, 1) the average minimum temperature is approximately 9°C., the maximum 21°C. and the mean average 15°C. The mean average relative humidity is 69%. These figures are the averages for the whole country but when studying this insect in relation to climatic factors it is better to divide the country into her three main regions, i.e., Lower Egypt (Delta), Middle Egypt and Upper Egypt. The average minimum temperature is thus 11°C. in the Delta, 7.6°C. in Middle Egypt and 8.6°C. in Upper Egypt. Sometimes the temperature reaches the freezing point or lower degrees. The average minimum temperature of all three zones is thus fairly near the critical low temperature at which both development and activity of this pest cease.

In the Spring (Table IX, 2), the average temperatures for the whole country are : minimum 14.7°C., maximum 28.5°C., by a mean of 21.6°C. The average relative humidity is 56 %. These figures are well within the insects thermovital range. When the humidity for the different regions is examined separately, it is found that the average relative humidity in the Delta is 68 %, in Middle Egypt 56 % and in Upper Egypt 44%. Although the temperature of all regions is favourable, yet the activity of the insect is affected by these differences in humidity.

While the relative humidity in the Delta is above 70 % in March, and slightly lower than that in April, it goes down to 64 % in May. These humidities according to Mac Gill's figures, allow rapid development and increase of the thrips population within the temperatures prevalent in the Delta in Spring.

In Middle Egypt the average relative humidity in March is about 62 %, in April 55 %, and in May 51 %. The relative humidity in March allows both, growth and reproduction of the insect to proceed as a decidedly lesser rate than in the Delta at this time. In April and May, thrips activity decreases gradually, as temperature increases and humidity decreases.

In Upper Egypt, the existence of thrips is in a critical position due to the low humidity there. In March, the average relative humidity is about 49 %, in April 43 % and in May 41 %. On the other hand, the temperature rises from an average of 21°C. in March to 26°C. in April and 29°C in May.

TABLE IX
Temperature and Humidity in Egypt

TIME	TEMPERATURE IN °C. AND PERCENTAGE OF RELATIVE HUMIDITY	REGIONS			AVERAGE	VARIATION
		DELTA	MIDDLE EGYPT	UPPER EGYPT		
(1) WINTER						
DECEMBER	Maximum	20.4	20.5	23.9	21.6	11.0
	Minimum	12.2	8.7	9.3	10.1	
	Average	16.4	14.6	16.6	15.9	
	Average R. H.	79.54	73.6	57.85	70.33	
JANUARY	Maximum	18.4	18.9	22.4	19.9	11.7
	Minimum	10.4	6.6	7.7	8.2	
	Average	14.4	12.7	15.0	14.0	
	Average R. H.	78.09	71.66	59.85	69.9	
FEBRUARY	Maximum	19.6	20.5	25.0	21.7	12.6
	Minimum	11.0	7.4	8.8	9.1	
	Average	15.4	14.0	16.9	15.4	
	Average R. H.	76.55	67.83	55.71	66.69	
WHOLE COUNTRY	Maximum	19.5	20.0	23.8	21.1	12.0
	Minimum	11.2	7.6	8.6	9.1	
	Average	15.4	13.8	16.2	5.1	
	Average R. H.	78.06	71.03	57.8	68.97	
(2) SPRING						
MARCH	Maximum	21.2	23.8	29.6	24.9	13.4
	Minimum	12.8	9.7	12.1	11.5	
	Average	17.0	16.7	20.8	18.2	
	Average R. H.	73.09	62.0	49.28	61.46	
APRIL	Maximum	23.6	28.0	34.7	28.8	14.0
	Minimum	15.1	12.5	16.8	14.8	
	Average	19.4	20.2	25.8	21.8	
	Average R. H.	68.09	54.66	42.71	55.15	
MAY	Maximum	26.2	31.9	37.7	31.9	14.0
	Minimum	17.8	15.6	20.4	17.9	
	Average	22.0	23.8	29.0	24.9	
	Average R. H.	63.9	50.83	40.85	51.86	
WHOLE COUNTRY	Maximum	23.7	27.9	34.0	28.5	13.8
	Minimum	15.2	12.6	16.4	14.7	
	Average	19.5	20.2	25.2	21.6	
	Average R. H.	68.36	55.83	44.28	56.16	

TABLE IX (continued)
Temperature and Humidity in Egypt

TIME	TEMPERATURE IN °C. AND PERCENTAGE OF RELATIVE HUMIDITY	REGIONS			AVERAGE	VARIATION
		DELTA	MIDDLE EGYPT	UPPER EGYPT		
(3) SUMMER						
JUNE	Maximum	28.6	34.8	40.0	34.5	13.7
	Minimum	20.8	18.5	23.2	20.8	
	Average	24.8	26.6	31.6	27.7	
	Average R. H.	66.9	53.0	40.71	53.54	
JULY	Maximum	30.4	35.5	40.0	35.3	13.0
	Minimum	22.8	20.2	23.9	22.3	
	Average	26.6	27.8	32.0	28.8	
	Average R. H.	70.82	58.33	42.28	57.14	
AUGUST	Maximum	31.2	35.0	39.3	35.2	12.6
	Minimum	23.4	20.4	24.1	22.6	
	Average	27.3	27.8	31.9	29.0	
	Average R. H.	73.9	61.66	46.0	60.52	
WHOLE COUNTRY	Maximum	30.1	35.1	39.8	35.0	13.1
	Minimum	22.3	19.7	23.7	21.9	
	Average	26.2	27.4	31.8	28.5	
	Average R. H.	70.54	57.66	42.99	57.07	
(4) AUTUMN						
SEPTEMBER	Maximum	30.0	32.3	37.1	33.1	12.0
	Minimum	22.4	18.6	22.2	21.1	
	Average	26.2	25.4	29.7	27.1	
	Average R. H.	74.45	64.83	50.71	63.33	
OCTOBER	Maximum	28.2	29.7	34.5	30.8	12.0
	Minimum	20.4	16.6	19.5	18.8	
	Average	24.3	23.1	27.0	24.8	
	Average R. H.	75.82	66.0	54.0	65.27	
NOVEMBER	Maximum	24.7	25.5	29.5	26.6	12.0
	Minimum	16.6	13.1	14.2	14.6	
	Average	20.6	19.4	21.9	20.6	
	Average R. H.	77.0	69.16	55.85	67.34	
WHOLE COUNTRY	Maximum	27.6	29.2	33.7	30.2	12.0
	Minimum	19.8	16.1	18.6	18.8	
	Average	23.7	22.6	26.2	24.2	
	Average R. H.	75.76	66.67	53.52	65.31	

In the Delta, *Thrips tabaci* usually appears on cotton seedlings in March. The population gradually increases to a maximum at the end of April or the beginning of May.

In Middle Egypt, the insect appears on cotton seedling always during March and early April, while in Upper Egypt, especially in the South, thrips attack is very slight, and damage to cotton seedling rarely observed. These observations were also recorded by Willcocks (195).

In Summer (Table IX, 3), the average temperature for the whole country is about 28.5° C., varying from a minimum of 22° C. to a maximum of 35° C. The average relative humidity is about 57 %.

The Delta has an average relative humidity of 67 % in June, 71 % in July, and 74 % in August with a mean average of 70.5 % for these three months. Although these humidities are suitable for complete growth and reproduction, according to Mac Gill, yet the rise in temperature above the optimum causes higher mortality and has an unfavourable effect on the insect's activity. This also agrees with Willcock's conclusions.

In Middle and Upper Egypt, the conditions during Summer are more unfavourable for thrips on account of the higher temperature and lower humidity. The relative humidity in Middle Egypt may be as low as 58 % on the average, while in Upper Egypt the average may be as low as 45 %. At the same time the average temperature in Middle Egypt is 27.4° C., varying from 35° maximum to 20° minimum. In Upper Egypt, the average temperature is about 32° C., with a maximum of 40° and a minimum of 24°. Under natural conditions in the fields, the rate of reproduction and increase of population in Summer decreases to a very low degree in both regions.

In Autumn (Table IX, 4), the relative humidity for the whole country averages 63 % and the mean average temperature is 24° C., with 30° C. as maximum and 18° as minimum. In the Delta, Middle Egypt and Upper Egypt, the mean average temperatures are : 24, 23 and 26° C. respectively with the average humidity of 76 %, 67 % and 53.5 % respectively. These figures explain why thrips is more active in the Delta than in Middle Egypt during Autumn, and why it is again less active in Upper Egypt. The Delta is thus shown to be the most favourable of the three regions for reproduction and activity of *Thrips tabaci*, owing to the more suitable climatic conditions prevailing there.

2. The Soil Factors

There is no doubt that the soil is an important factor in the life history and bionomics of *Thrips tabaci*, especially in view of the fact that it spends part of its life cycle in the ground. The nature of the soil has great influence on the early stages of the insect living therein. Clay soils, light

soils, sandy soils, lime soils and humus soils, all have different effects on the prepupal and pupal stages. The differences are most obvious when water has been added to the soil, because the coagulation of the particles differs in each soil especially after evaporation of drainage. It is well known that the higher the proportion of clay in any soil, the more cohesive it will be after drying. The cohesion found in clay soils is unfavourable to the prepupae and pupae, and thus causes lowering of the thrips population by preventing the emergence of the adults.

Wardle (184) believes that the nature of the soil exerts a greater influence on the thrips population than heavy rain or flooding. The more cohesive the soil after drying, the fewer adults will emerge. In soils where the amount of clay is not more than 15 %, the degree of cohesion is so low that the soil remains loose. If the soil contains between 15 and 30 % of clay, moderate rain is sufficient to change the surface into a cohesive layer for several days, provided the temperature is fairly high. When there is more than 30 % clay, the water must be accompanied by high pressure, e.g. heavy rain, heavy irrigation or flooding in order to bring about coagulation of the soil surface. Even then, this coagulation does not last long, because, where the temperature is high and the relative humidity is low, the rate of evaporation of the soil water is increased to such a degree that in a few days the soil is quite dry with deep cracks.

In the areas where rainfall is abundant, the surface of clay soils tends to coagulate. This condition is lessened to a great extent by cultural methods such as harrowing, ploughing, the addition of salts or humus, or by planting shallow rooting crops. Such cultural practices improve the nature of the soil, but they also tend to increase the thrips population, especially if the interval between successive waterings or rainfalls is long.

In dry or semi-dry regions, heavy clay soils have a tendency to break up into a fine powder which makes the soil favourable for the development of thrips. The presence of sodium- or potassium carbonate in such areas helps to keep the soil compact. In addition to this, the plants growing in these areas usually have a thick epidermis which makes them less susceptible to thrips attack. It may be stated that these regions, in general, are not favourable to thrips.

Wardle (184) states that in arid and semi-arid areas, modern scientific methods of soil cultivation such as tillage, drainage, regular irrigation, etc., while improving the texture of the soil also tend to make the conditions favourable for Thysanoptera. The large volume of water required in such cases owing to high surface evaporation, helps in surface caking, and so hinders thrips multiplication. This advantage is offset by the long intervals between waterings, also by tillage and by the fact that irrigation water

does not reach the crests of the ridges which therefore remain powdery throughout.

The author agrees with Wardle that such agricultural operations are necessary for cotton plants in spite of the encouragements they give to thrips. Negligence in tilling, overwatering or increasing the number of irrigations lessens the number of flowers and retards boll formation, thereby causing greater loss through increased bollworm infestation.

There are other aspects as to the relation between the attacks of *Thrips tabaci* and the number of waterings, the intervals between successive waterings, the common and the improved methods of cultivation, the time of sowing, the natural and artificial manuring, and the varietal differences of the cotton plant. These problems will be dealt with in a separate paper.

3. Natural Enemies

A study of the available literature showed that *Thrips tabaci* has got a fairly good number of natural enemies abroad. They are tabulated below.

Here in Egypt, Willcocks (195) mentioned that the only predator of importance is an *Orius* (*Triphleps*) sp., particularly common and occurring in considerable numbers on berseem (*Trifolium alexandrinum*) infested with thrips, but unfortunately it seems very much less common on young cotton when it is infested with the same pest.

Willcocks (195) also has discovered the disappearance of thrips pupae in the soil of his breeding jars. In their place he has found insects which he believed to be Collembola and suspected that these small creatures may have destroyed the thrips pupae.

The author was fortunate to examine under laboratory conditions some of the natural enemies of this insect found in Egypt, such as : (1) *Oecanthus turanicus* Uv. (Orthopt., Gryllidae), (2) *Orius albidipennis* Reut. (Hemipt. Anthocoridae), (3) *Chrysopa vulgaris aegyptiaca* Nav. (Neuropt., Chrysopidae), (4) *Coccinella undecimpunctata* L. (Coleopt., Coccinellidae), and (5) *Syrphus corollae* F. (Diptera, Syrphidae).

(1), (2) and (4) were observed feeding on *Thrips tabaci* in both the larval and adult stages. Larvae of (5) were also seen feeding upon the larvae of thrips while the larvae of (3) were noticed to prey on both, larvae and adults.

In addition to the above, Priesner mentions in his manuscript notes *Orius laevigatus* Fieb. and a hitherto undescribed *Aeolothrips* form (closely allied to *Ae. collaris* Pr.) as predators to *Thrips tabaci*. Occasionally he observed Acarina larvae of the family Trombididae attached to the abdomen of female specimens of *Thrips tabaci*. Such Trombidiid larvae have been known for a long time to live ectoparasitic on Thysanoptera.

At any rate, native parasites and predators do not play any role in checking this pest. Therefore attempts are being made here in Egypt to reintroduce parasites of Thrips from the Gold Coast. Previous efforts in this respect have been a failure owing to the death of the contents of consignments for various reasons.

Up to the present, climatic conditions are the important factors which determine the amount of thrips population.

NATURAL ENEMIES OF THRIPS TABACI

OBSERVED OUTSIDE EGYPT

I. Eumycetes : Phycomycetes (Entomophthoraceae)

II. Nematodes ? (145 b)

III. Hexapoda

(a) Collembola (195).

(b) Orthoptera (Gryllidae) : *Oecanthus longicauda* Mats. (79).

(c) Thysanoptera (Aeolothripidae) : *Aeolothrips annectans* Hood (175), and *Aeolothrips fasciatus* L. (40, 175).

(d) Hemiptera (Anthocoridae) : *Orius persequens* B. Wh. (84), *Orius insidiosus* Say (81, 118), *Orius niger* Wlff. (9), and *Orius tristicolor* B. Wh. (76, 122).

(e) Coleoptera (Coccinellidae) : *Coccinella novemnotata* (81), and *Hippodamia convergens* (81).

(f) Hymenoptera (Chalcidoidea) : *Dasyscapus parvipennis* Gah. (54, 58), *Thripoctenus brui* Vuill. (56, 86, 145 b, 146, 147, 181), and *Thripoctenus russelli* Crfd. (57).

(g) Diptera (Syrphidae) : *Syrphus* spec. (81).

(h) Neuroptera (Chrysopidae) : *Chrysopa* spec. (81).

IV. Arachnoidea

Acarina : *Anystis astripus* Ksch. (145 b) (Anystidae); and *Typhlodromus thrips* (103) (Gamasidae-Parasitidae).

V. Aves

Poultry (116, 174).

VIII. GEOGRAPHICAL DISTRIBUTION

On examining the lists of host plants and the regions where *Thrips tabaci* is found, it becomes obvious that this insect can exist under a variety of ecological conditions varying from the temperate zones to the tropics. This explains the ease with which it becomes established and distributed

wherever it is introduced. It also accounts for the serious damage it causes and for the difficulty of its control.

Owing to its present wide distribution, the country of origin is difficult to ascertain; *Thrips tabaci* may be native of Asia, Australia or North America. In Egypt, in spite of the presence of some of its natural enemies, this insect is found throughout the country, in the cultivated parts as well as in the desert, because the ecological factors and the wide variety of host plants are eminently suited to its development everywhere. It became at present such a serious pest to cotton seedlings that the loss caused by this insect to young plants in some years amounted to 90 %, especially in the North of the Delta. In such cases, the resowing of cotton, has to be repeated several times, causing retardation of growth and thus further susceptibility to increased attack by cotton leafworm and bollworms which again increase damage to the crop and lessen quality of the cotton-wool.

The following list gives the insect's most important localities throughout the world:

Africa

Egypt, Kenya (98), Union of South Africa (87).

America

(a) North America : Canada (Ontario, 28, 29, 137; Quebec, 64); British Columbia (173); United States : Carolina (45, 190), California (176), Connecticut (176), Dakota (154), Florida (98, 186, 187, 189), Indiana (90), Iowa (80, 85), Kansas (42), Louisiana (44), Massachusetts (18 b, 19, 21), Michigan (67), New Mexico (115), New York (107), Ohio (119), Pennsylvania (98), Texas (37, 151 b), Virginia (22), Wisconsin (191, 192); and Mexico (111).

(b) South America : Brazil (16, 98), and Chile (126).

Asia

China (92); India (2, 5, 98, 124); Japan (79, 86, 145 b); Korea (145 b); Palestine (134); Cyprus (128 d); Sinai; Siberia (151 a); and Turkestan : Syr Darya (33).

Australia (3, 4, 68, 97, 98, 150)

New England (53), New South Wales (3), Queensland (66, 168), and Victoria (1).

Europe

Albania (98), Austria (127), Belgium (108), Great Britain (98, 108, 161, 166), Bulgaria (10, 36, 110), Caucasasia (136), Czechoslovakia (12, 98, 152), France (98, 106), Germany (23, 98, 135), Hungary (98), Italy (98), Latvia (88, 120), Rumania (63, 91, 98), Russia (6, 50, 61, 98, 131, 155), Spain (145 b), Sweden (98), and Yugoslavia (98).

Ocean Islands

(a) Atlantic Ocean : Bermuda (98, 118, 142), Canaries (128b), Cuba (26), Porto Rico (43, 143, 144, 160, 167), Iceland (104b), Juan Fernandez (133b), and Madeira (128c).

(b) Indian Ocean : Mauritius (41, 113, 183).

(c) Pacific Ocean : Dutch East Indies (55, 56, 58, 98, 180a, 181), Formosa (145b, 170, 172), Hawaii (32, 46, 71, 145a), Micronesia (145b), Philippines (57), and New Zealand (35).

IX. HOST PLANTS OF *THRIPS TABACI* IN EGYPT AND IN FOREIGN COUNTRIES

Priesner and the author inspected nearly all parts of Egypt for a thorough survey of the different species of Thysanoptera and their host plants. Those of *Thrips tabaci* are given in List A. They are 129 host plants belonging to 37 families. In List B the host plants of this insect as recorded by investigators abroad amount to 141 species, belonging to 41 families.

Of the plant families on which this thrips was found in Egypt, the following are the most important as to frequency of occurrence of thrips on them :

Caryophyllaceae, Chenopodiaceae, Compositae, Convolvulaceae, Cucurbitaceae, Cruciferae, Gramineae, Leguminosae, Liliaceae, Malvaceae, Salicaceae, and Solanaceae.

Amongst all these, young cotton (*Gossypium* spp.) and onion (*Allium cepa*), the latter particularly when cultivated for seed crop, both are the two most important crops, enormously injured by *Thrips tabaci* in this country. In some years, when the ecological conditions for this insect are most favourable, the intensity of population is so high that the damage may reach 90 % of the cotton seedlings and the onion seed yield. This is based on field observations of at least 10 years.

The numerous host plants make the question of control a difficult one but it is noticed from the survey mentioned above, that a great number of the host plant species given, grow as weeds by the side of roads and on the banks of the irrigation canals and drains, as well as in farms and orchards, or in the desert. This would suggest clean cultivation as an important factor in checking this pest.

(A) Host plants of *Thrips tabaci* in Egypt, according to Priesner's and the authors investigations (1)

(1) Gramineae : *Cynodon dactylon* Pers. (l, fl), *Hordeum maritimum* With. (fl), *Hordeum vulgare* L. (l, fl), *Imperata cylindrica* L. (fl), *Poly-*

(1) Plant names in ordinary types indicate such plants on which beside adult thrips also larvae were found. *Thrips tabaci* was taken either in the inflorescences (fl) or on the leaves (l) of the plant concerned, or on both.

pogon monspeliensis Desf. (fl), *Saccharum officinarum* L. (l), and *Triticum sativum* Vill. (fl).

(2) Araceae: *Zantedeschia* (*Calla*) *aethiopica* L. (fl).

(3) Liliaceae: *Allium cepa* L. (fl, l), *Allium porrum* L. (fl, l), and *Asphodelus tenuifolius* Cav. (fl).

(4) Amaryllidaceae: *Polianthus tuberosa* L. (fl).

(5) Cannaceae: *Canna* spec. (fl).

(6) Orchidaceae: *Habenaria bifolia* R. Br.

(7) Salicaceae: *Salix babylonica* L. (l), and *Salix salsaf* Forsk. (l).

(8) Moraceae: *Morus alba* L. (l).

(9) Polygonaceae: *Calligonum comosum* L'Herit. (fl).

(10) Chenopodiaceae: *Chenopodium murale* L. (fl, l), and *Kochia muricata* L. (fl).

(11) Caryophyllaceae: *Dianthus caryophyllus* L. (fl, l), and *Silene rubella* L. (fl).

(12) Papaveraceae: *Papaver rhoeas* L. (fl), and *Papaver somniferum* L. (fl).

(13) Fumariaceae: *Fumaria officinalis* L. (fl).

(14) Cruciferae: *Alyssum compactum* (fl), *Alyssum maritimum* Lam. (fl), *Alyssum minimum* Willd. (fl), *Brassica oleracea* L. (fl, l), *Cheiranthus cheiri* L. (fl), *Coronopus niloticus* Del. (fl.), *Diploxys harra* Boiss. (fl), *Eruca sativa* Mill. (fl, l), *Matthiola livida* D.C. (fl), *Raphanus sativus* L. (fl, l), *Sisymbrium irio* L. (fl), and *Zilla spinosa* Forsk. (fl).

(15) Resedaceae: *Ochradenus baccatus* Del. (fl), and *Reseda odorata* L. (fl).

(16) Rosaceae: *Rosa centifolia* L. (fl).

(17) Leguminosae: *Acacia arabica* var. *nilotica* Del. (fl), *Acacia farnesiana* Willd. (fl), *Acacia saligna* (fl), *Astragalus sieberi* D.C. (fl), *Bauhinia* spec. (fl), *Caesalpinia sepiaria* Roxb. (fl), *Lens esculenta* Mnch. Meth. (fl, l), *Lupinus termis* Forsk. (fl, l), *Medicago sativa* L. (fl), *Melilotus indicus* All. (fl), *Ononis vaginalis* Vahl. (fl), *Phaseolus vulgaris* L. (fl, l), *Pisum sativum* L. (fl), *Poinciana regia* Boj. (fl), *Retama raetam* Webb. (fl), *Sarothamnus* spec. (fl), *Trifolium alexandrinum* L. (fl), *Trifolium resupinatum* L. (fl), *Trigonella foenum-graecum* L. (fl), *Trigonella stellata* Forsk. (fl), and *Vicia faba* L. (l).

(18) Geraniaceae: *Erodium glaucophyllum* L. (fl).

(19) Tropaeolaceae: *Tropaeolum majus* L. (fl, l).

(20) Linaceae: *Linum usitatissimum* L. (fl).

(21) Rutaceae: *Citrus* spp. (fl).

(22) Meliaceae: *Melia azedarach* L. (fl).

(23) Euphorbiaceae: *Acalypha* spec. (fl, l), and *Crozophora tinctoria* S. Juss. (fl, l).

(24) Malvaceae: *Althaea rosea* Cav. (fl, l), and *Gossypium* spp. (fl, l).

(25) Tamaricaceae: *Tamarix* spp. (fl.)

(26) Umbelliferae: *Ammi majus* L. (fl), *Anethum graveolens* L. (fl), *Crithmum maritimum* L. (fl), and *Pithyranthus tortuosus* Benth. and Hook (fl).

(27) Primulaceae: *Primula malacoides* Franch. (fl).

(28) Asclepiadaceae: *Asclepias curassavica* L. (fl).

(29) Convolvulaceae: *Convolvulus arvensis* L. (fl, l), and *Ipomoea purpurea* Roth (fl).

(30) Boraginaceae: *Echium rauwolphi* Del. (fl), *Echium sericeum* Vahl. (fl), and *Heliothropium* spec. (fl).

(31) Verbenaceae: *Lantana camara* L. (fl), *Lippia nodiflora* Mehx. (fl), *Verbena hybrida* Voss. (fl), *Verbena supina* L. (fl), and *Vitex agnus-castus* L. (fl).

(32) Labiatae: *Lavandula coronopifolia* L. (l).

(33) Solanaceae: *Capsicum annuum* L. (l), *Cestrum diurnum* L. (fl), *Solanum lycopersicum* L. (fl, l), *Solanum melongena* L. (l), *Solanum tuberosum* L. (fl, l), and *Schizanthus* spec. (fl).

(34) Scrophulariaceae: *Antirrhinum majus* L. (fl, l), and *Scrophularia deserti* Del. (fl).

(35) Bignoniaceae: *Jacaranda ovalifolia* R. Br. (fl).

(36) Cucurbitaceae: *Citrullus vulgaris* Schrd. (fl, l), *Cucurbita moschata* Duch. (fl, l), and *Cucurbita pepo* L. (fl, l).

(37) Compositae: *Achillea santolina* L. (fl), *Acroclinium* spec. (fl), *Ambrosia maritima* L. (fl), *Anacyclus alexandrinus* Willd. (fl), *Anthemis melampodina* Del. (fl), *Artemisia judaica* L. (fl, l), *Bellis perennis* L. (fl), *Calendula aegyptiaca* Pers. (fl, l), *Calendula officinalis* L. (fl), *Carthamus tinctorius* L. (fl, l), *Chrysanthemum anethifolium* (fl), *Chrysanthemum cinerariaefolium* Trev. (fl), *Chrysanthemum coronarium* L. (fl), *Cineraria* spec. (fl), *Cirsium syriacum* L. (fl.), *Conyza dioscoridis* Desf. (fl, l), *Gerbera* spec. (fl), *Helianthus* spp. (fl), *Inula crithmoides* L. (fl), *Odonotospermum graveolens* Sch. Bip. (fl), *Pluchea (Conyza)* spec., *Pulicaria crispa* Benth and Hook. (fl), *Pulicaria undulata* D.C. (fl), *Pyrethrum (Chrysanthemum)* spec., *Senecio coronopifolius* Desf. (fl), *Senecio vulgaris* L. (fl), *Silybum marianum* Gaertn. (fl), *Sonchus oleraceus* L. (fl), and *Tagetes erecta* L. (fl).

(B) Host plants of *Thrips tabaci*, as recorded from abroad ⁽²⁾

(1) Gramineae: *Avena* spec. (138), *Cenchruss* spec. (145 a), *Eleusine indica* L. (145 a), *Panicum sanguinale* L. (186), *Paspalum conjugatum* Gerg. (145 a), *Secale cereale* L. (140), *Syntherisma chinensis* Nees (145 a), *Syntherisma sanguinalis* L. (145 a), *Triticum sativum* Vill. (138), and *Zea mays* L. (138).

(2) Bromeliaceae: *Ananas sativus* Schult. (71, 145 a).

(3) Liliaceae: *Allium ascalonicum* L. (44), *Allium cepa* L. (8, 145 a, 166), *Allium fistulosum* L. (55), *Allium porrum* L. (55, 181), *Allium sativum* L. (130), *Asparagus plumosus* Baker (123), and *Yucca* spec. (145 a).

(4) Orchidaceae: *Habenaria bifolia* R. Br. (127).

(5) Moraceae: *Morus alba* L. (114).

(6) Polygonaceae: *Fagopyrum esculentum* Moench. (74).

(7) Chenopodiaceae: *Beta vulgaris* L. (126).

(8) Amarantaceae: *Amarantus albus* L. (145 a), and *Amarantus retroflexus* L. (145 a).

(9) Nyctaginaceae: *Mirabilis jalapa* L. (145 a), and *Mirabilis* spec. (51 b).

(10) Phytolaccaceae: *Phytolacca acinosa* Roxb. (145 a).

(11) Portulaccaceae: *Portulacca oleracea* L. (145 a).

(12) Caryophyllaceae: *Dianthus caryophyllus* L. (8, 145 a, 161), and *Saponaria* spec. (51 b).

(13) Ranunculaceae: *Helleborus foetidus* L. (51 b).

(14) Papaveraceae: *Papaver* spec. (51 b).

(15) Cruciferae: *Brassica nigra* Koch (145 a), *Brassica oleracea* L. and varieties (83, 96, 124, 134, 135), *Iberis* spec. (51 b), *Lepidium latifolium* L. (51 b), *Raphanus sativus* L. (73, 145 a), and *Senebiera didyma* Pers. (145 a).

(16) Resedaceae: *Reseda odorata* L. (51 b).

(17) Crassulaceae: *Sedum* spec. (51 b).

(18) Rosaceae: *Fragaria vesca* L. (1), *Potentilla* spec. (51 b), *Prunus domestica* L. (51 b), *Pyrus communis* L. (70), *Pyrus malus* L. (70), *Rosa* spp. (8, 161); *Rubus fruticosus* L. (174), and *Rubus idaeus* L. (174).

(19) Leguminosae: *Acacia farnesiana* Willd. (145 a), *Alhagi camelorum* Fisch. (51 b), *Astragalus cicer* L. (51 b), *Cajanus cajan* L. (145 a), *Cassia mimosoides* L. (145 a), *Cassia occidentalis* L. (145 a), *Cassia tora* L. (145 a), *Crotalaria juncea* L. (145 a), *Crotalaria saltiana* Andr. (145 a), *Crotalaria spectabilis* Roth. (145 a), *Glycine soya* Sieb. and Zucc. (145 a, 197), *Lathyrus odoratus* L. (196), *Leucaena glauca* L. Benth. (145 a), *Lupinus*

⁽²⁾ These host plant records were extracted from the *Review of Applied Entomology*, 1913-1941.

angustifolius L. (34), *Lupinus* spec. (145 a), *Medicago lupulina* L. (51 b), *Medicago sativa* L. (139, 145 a), *Melilotus* spec. (51 b), *Mimosa pudica* L. (145 a), *Phaseolus lathyroides* L. (145 a), *Phaseolus vulgaris* L. (196), *Pisum sativum* L. (145 a, 191), *Prosopis juliflora* Sw. (145 a), *Trifolium protense* L. (73), *Trifolium repens* L. (51 b), *Vicia faba* L. (16), and *Vigna sinensis* L. (145 a).

(20) Geraniaceae: *Geranium pyrenaicum* L. (51 b).

(21) Oxalidaceae: *Oxalis maritima* Zucc. (145 a).

(22) Tropaeolaceae: *Tropaeolum majus* L. (65, 191).

(23) Linaceae: *Linum usitatissimum* L. (120).

(24) Rutaceae: *Citrus* spp. (134).

(25) Euphorbiaceae: *Euphorbia hirta* L. (145 a).

(26) Vitaceae: *Vitis vinifera* L. (134).

(27) Malvaceae: *Gossypium* spp. (44, 197), and *Malva* spec. (145 a).

(28) Sterculiaceae: *Theobroma cacao* L. (39), and *Waltheria americana* L. (145 a).

(29) Theaceae: *Thea sinensis* L. (*viridis* L.) (5).

(30) Lythraceae: *Cuphea hyssopifolia* H.B.K. (145 a).

(31) Araliaceae: *Nothopanax giulfoylei* Merr. (145 a).

(32) Umbelliferae: *Apium montanum* H.B.K. (124, 188), *Daucus carota* L. (124, 145 a), *Foeniculum vulgare* Mill. (52), *Hydrocotyle asiatica* L. (145 a), and *Sarum* spec. (51 b).

(33) Primulaceae: *Cyclamen* spec. (51 b).

(34) Convolvulaceae: *Ipomoea tuberculata* Roem. (145 a).

(35) Borraginaceae: *Bothriospermum tenellum* F. and M. (145 a), and *Symphytum* spec. (51 b).

(36) Verbenaceae: *Lantana camara* L. (145 a), *Stachytarpheta dichotoma* Vahl. (145 a), and *Verbena bonariensis* L. (145 a).

(37) Labiatae: *Brunella vulgaris* L. (51 b), *Lamium amplexicaule* L. (51 b), *Mentha sativa* L. (67), *Nepeta cataria* L. (51 b), and *Stachys arvensis* L. (145 a).

(38) Solanaceae: *Atropa belladonna* L. (12), *Capsicum annuum* L. (74), *Datura stramonium* L. (51 b), *Nicandra physaloides* Pers. (145 a), *Nicotiana rustica* L. (152, 171), *Nicotiana tabacum* L. (51 b), *Solanum lycopersicum* L. (55, 166), *Solanum nigrum* L. (51 b), *Solanum nodiflorum* Jaqu. (145 a), and *Solanum tuberosum* L. (179).

(39) Rubiaceae: *Richardsonia scabra* St. Hil. (145 a).

(40) Cucurbitaceae: *Cucumis dipsaceus* Ehrh. (145 a), *Cucumis melo* L. (51 b), *Cucumis sativus* L. (164, 198) and *Cucumis* spec. (124, 166)

(41) Compositae: *Acanthospermum xanthoides* D.C. (145 a), *Ageratum conyzoides* L. (48, 145 a), *Ambrosia artemisiaefolia* L. (145 a), *Bidens*

pilosa L. (145 a), *Chrysanthemum cinerariaefolium* Trev. (193, 194), *Chrysanthemum* spec. (145 a), *Chrysanthemum inodorum* L. (51 b), *Dahlia variabilis* Desf. (150), *Emilia sagittata* Vahl. (145 a, 148), *Erigeron canadensis* L. (145 a), *Eupatorium cannabinum* L. (51 b), *Gaillardia* spec. (51 b), *Gnaphalium luteo-album* L. (145 a), *Helianthus annuus* L. (177), *Lactuca sativa* L. (139), *Pluchea indica* Cass. (145 a), *Senecio hieraciifolia* L. (145 a), *Sonchus oleraceus* L. (145 a), *Tithonia rotundiflora* Mill. (145 a), and *Vernonia cinerea* Less. (145 a).

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Studies on the Mediterranean Fruit-fly, *Ceratitis capitata* Wied.

[Diptera-Trypanidae]

III. FACTORS LIMITING THE ATTACK

OF THE MEDITERRANEAN FRUIT-FLY IN CITRUS FRUITS ⁽¹⁾

(with 4 Text-Figures, 1 coloured Plate, 19 Tables, and 1 Curve)

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C O N T E N T S

Introduction. — *Analysis of Citrus juices.* — *The physical factors : thickness and mechanical resistance of the rind.* — *The chemical factors : essential oils, glucosides, and pectins.* — *Percentage of water in the fresh rind of Citrus fruits.* — *Comparative concentration of pectins in the water content of the rind.* — *Infestation of Citrus fruits in different parts of the country* — *Factors limiting the infestation of Citrus fruits.* — *Average temperature and humidity in different localities.* — *Saturation deficiency of the air in different localities.* — *Index of infestation in Assiut, Fayoum, and Giza.* — *Index of infestation in Benha, Zagazig, and Alexandria.* — *Discussion.* — *Summary.* — *Acknowledgments.* — *References.*

INTRODUCTION

It has come to be realised, in the last few years, that more basic and illuminating studies on the insect's behaviour is of fundamental importance as it offers possibilities that advantage may be taken of a certain weak spot in devising its effective control.

(¹) Part I : « The structure and operation of the reproductive organs » has been published in this Bulletin, vol. XXII, 1938 [1939].

Part II : « Biology and Control » has been published in this Bulletin, vol. XXXI, 1947.

The points involved in the behaviour of the fruit-fly, and are, as yet, very little understood, are :

(1) Many eggs are usually deposited in Citrus fruits, and yet very few flies succeed in reaching maturity.

(2) The eggs are usually deposited about the navel end of the fruits.

(3) The Egyptian lime and the common acid lemon are not infested while oranges and tangerines are.

(4) The infestation of Citrus fruits is very rare in Upper Egypt.

(5) The attack increases in the years of high Nile flood.

(6) The infestation increases with the ripening of the fruits.

If we examine carefully the oranges sold in our markets, we find that the majority of them have one or more punctures usually containing dead larvae and sometimes dead eggs. In an orchard in the Barrage, it was found that out of 1018 egg-masses deposited in different kinds of Citrus fruits, only 62 larvae succeeded in gaining access to the pulp. About 18 % of the eggs failed to hatch. It is gathered therefore that most of the mortality takes place in the larval stage.

Had it not been for the overwhelming mortality of the larvae our Citrus fruits would have been seriously affected by this fly.

The importance of an adequate and thorough knowledge of the remarkable factors working to limit the destruction caused by this fly has become increasingly evident in connection with its control.

Now at first sight this mortality seems to be caused by the acidity of the fruit juice. The favourite and available example often invoked to support this idea is the fact that the fly does not infest either lemons or other Citrus fruits before they mature.

Salvastano (1914) has already compared the sugar content and acidity of different varieties of Citrus in various provinces of Italy with severity of attacks by *Ceratitis capitata* Wied., and arrived at the conclusion that the insect does not attack the Italian lemons at all. As regards other fruits, his conclusion was that cultivators trying to increase the sugar content and to reduce the acidity of the fruit breed varieties more susceptible to the attack of the fruit-fly. Oranges and tangerines are attacked most because they are sweeter and less acidic.

It was then thought desirable to analyse the juice of three varieties of Citrus fruits — common Egyptian oranges (Balady oranges), common Egyptian tangerines, and sweet lime of Egypt — at intervals of 10 days from August till March for three successive years, to find out the average percentage of protein, sugars and acids and to ascertain whether the attack is a correlated expression of the separate or the combined influence of two or more of these three, constituents.

THE AVERAGE ANALYSIS OF CITRUS JUICE IN 1941, 1942, AND 1943

The analysis were carried out three times a month, once every ten days and are given on Table I.

TABLE I

VARIETY OF FRUIT	CONSTITUENTS	MONTH PERCENTAGE							
		VIII	IX	X	XI	XII	I	II	III
Common	Protein	0.44	0.45	0.48	0.50	0.55	0.59	0.64	0.75
Egyptian	Sugars	5.90	5.70	5.90	7.60	9.90	9.30	9.70	10.50
oranges	Acids	3.20	2.25	2.25	1.77	1.55	1.40	1.20	1.20
Common	Protein	0.48	0.42	0.44	0.46	0.50	0.55	0.61	0.72
Egyptian	Sugar	2.70	3.70	5.70	7.25	9.30	9.30	10.40	11.20
tangerines	Acids	6.40	4.85	3.44	1.60	1.72	0.93	0.96	0.91
Sweet lime	Protein	0.37	0.32	0.38	0.38	0.35	0.34	0.46	0.48
of Egypt	Sugar	8.40	7.30	7.80	8.20	8.70	8.50	8.00	8.20
	Acids	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.07

The following is also the average analysis of some varieties of Citrus fruits in January.

TABLE II

VARIETY OF FRUIT	DATE	PERCENTAGE OF PROTEIN	PERCENTAGE OF SUGARS	PERCENTAGE OF ACIDS
Egyptian lime.....	2. 3.1942	0.37	0.16	8.06
Common acid lemon	20.12.1941	0.31	1.48	6.08
Sugar oranges.....	19.11.1942	0.78	9.37	0.14

The study of these analysis yields important information, thus :

(1) At the beginning of the season, before maturing, the sweet lime contains a percentage of both acids and sugars which is almost equal to that at the end of the season and yet the attack does not appear at the outset of the season. Furthermore, if the rate of attack is proportional to the amount of acids as Salvastano claims, we would expect that the attack of the sweet lime would be comparatively heavier than the others, which is not the case.

(2) The Sugar oranges (Table II) has less acid than Tangerines and yet it is not so heavily attacked (Table XI).

It is true that the Egyptian lime and the common acid lemon contain a high percentage of acid (see Table II) and at the same time they are not infested. This suggests that the acidity might be the limiting factor, but, if we cut them and place some larvae on the pulp itself, as soon as they hatch, they will survive, but it was noticed that the pupae are rather small, their average weight on the day of their formation being 6 mgrms, while on other fruits their average weight is 8 mgrms. This decrease of weight may be ascribed as follows :

(a) There is deficiency of both sugars and protein (see Table II).

(b) The high acidity of lemon seems to have a deterring effect on the growth of yeast plants; the digestion of which seems to compensate for the deficiency of protein.

This was demonstrated by :

A medium of banana was prepared in petri dishes to which citric acid was added in different concentrations, from 1 to 30 %. After autoclaving the medium it was then infected by *Saccharomyces ellipdoides* obtained from the Faculty of Agriculture, Giza. It was noticed that the area occupied by the yeast on the surface of the culture decreases gradually till the percentage of acid reaches 15 %, when the yeast growth becomes insignificant.

It could be gathered, therefore, that although the temptation to interpret the rate of attack in terms of acidity is very strong, yet all these facts do not tend to account for any possible correlation. We have to trace therefore the cause in the peel itself. For this reason a detailed and systematic study of the peel might provide fundamental criteria. The factors advanced fall under two categories : physical and chemical factors.

THE PHYSICAL FACTORS

(1) The thickness of the peel

It has been suggested that if the peel is thick, the hatching larva may take a long time to reach the pulp and therefore be subject to starvation.

That the thickness of the peel has no important bearing upon the rate of infestation was shown by measuring the thickness of the peel of 50 of each of the fruits, as shown in Table III.

If on the basis of these data the thickness of the peel were a decisive factor, one would expect that grape-fruit which have a very thick rind would have the least infestation, while the Egyptian lime would have the most, which is not the case.

In addition, it has been mentioned in a previous paper that the punctures are almost always inflicted on the navel end of the fruits, but it

TABLE III

VARIETY OF FRUITS	AVERAGE THICKNESS OF THE RIND IN MILLIMETERS		
	STEM END	MIDDLE PART	NAVEL END
Egyptian lime..	1.50	1.50	1.70
Acid lemon.....	4.50	4.50	5.00
Grape fruit..	13.00	12.50	12.00
Sweet lime of Egypt	2.50	2.50	2.45
Bitter oranges.....	7.70	7.50	7.50
Common Egyptian oranges .	4.00	4.10	4.00
Java oranges	8.12	7.50	7.10
Navel oranges.....	4.50	4.50	4.00
Sugar oranges.....	4.00	4.00	4.00
Common tangerines	3.70	3.70	3.70

seems, that there is no appreciable difference in the thickness of the rind in most fruits, between the navel and the stem ends.

(2) The mechanical resistance of the rind to oviposition

It is natural that the fly in inflicting its punctures should choose the place that ensures no undue waste of energy. For this reason it was thought desirable to devise an apparatus for measuring the comparative resistance of the rind of different fruits to the thrust of the ovipositor. This apparatus, made chiefly of wood (fig. 1), and constructed as follows :

A basal piece of wood (fig. 1, BSL) about 45 cms. in length and 8 cms. in width has three pillars standing at right angle to it, one on each side, and one in the middle. One of the side pillars carries an electric bell and a transformer, the other has a board of cork (fig. 1, CRP) stuck along its whole front surface. A graduated ruler is fixed along its length on the outer side of the cork pad. In front of it and fixed to the basal plate, there is a ring-like tray (fig. 1, TRY) that can be moved up and down. The middle pillar carries a fulcrum of the third class. Its left handle has a little strip of tin on its upper surface (fig. 1, SRT) and when it comes near the end, it turns towards the cork pad at right angle to the hand of the fulcrum so as to form an indicator (fig. 1, IND). This handle also carries a tin pan (fig. 1, PAN). The strip of tin is connected by a wire at its origin to an electric bell through a transformer. A standardised needle (Sharpps No. 12, manufactured by Abdel Marral Ltd., Redditch, England) is fixed at right angle to the end of the left handle of the fulcrum on its lower surface (fig. 1, NDL). There is

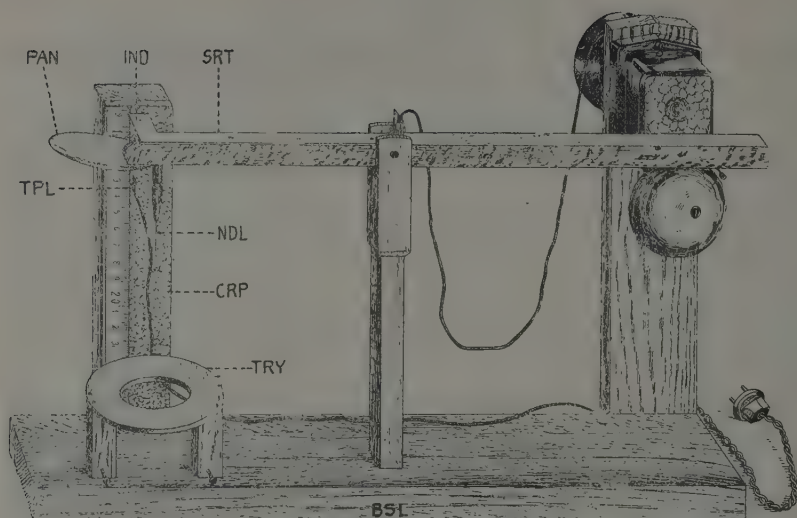


Fig. 1: Apparatus for measuring the resistance of the Citrus rind (BSL, basal piece of wood; CRP, cork pad; IND, indicator; NDL, needle; PAN, pan; SRT, strip of tin; TPL, a square piece of tin with a needle attached to it; TRY, circular tray).

also a small piece of tin about 1 square cm. (fig. 1, TPL) which has a small needle welded at right angle to it and is also connected to the bell by another wire so as to complete the electric circle when it touches the indicator.

Now, if we want to compare the resistance of the rind of a fruit, we

TABLE IV

VARIETY OF FRUIT	TIME IN SECONDS
Egyptian lime.....	0
Common acid lemon.....	30
Grape fruit.....	13
Sweet lime.....	1
Bitter oranges.....	14.5
Common Egyptian oranges.....	23
Java oranges.....	14
Navel oranges.....	12
Sugar oranges.....	7
Common Egyptian tangerines.....	0

place it on the circular tray and move it up or down until it touches the tip of the needle. Then we fix the tin plate, to which the needle is welded, to the cork pad so that the distance between this plate and the indicator will be a fixed length, viz. 4 mms. If we place a given weight on the pan, the needle will gradually go down through the rind until the bell rings. By means of a stop watch we can find out the time taken by the needle with the given weight acting on it (100 grs.) to penetrate the rind for a distance of 4 mms.

The average resistance of the rind of different fruits taken on the 15th. of January from the Barrage was as given on Table IV.

If we exclude the fruits whose peel is less than 4 mms. in thickness, which is the length the needle has to go through, we will find that the rate of infestation is still not in accordance with the resistance of the peel (see Table XI).

THE CHEMICAL FACTORS

The main constituents of the rind of Citrus fruits are : essential oils, glucosides, and pectins.

(1) The essential oils

Back and Pemberton (1915) conducted some experiments to throw some light on the factors determining the attack of the Mediterranean Fruit-fly on Citrus fruits. They squeezed the peel on the hatching larvae and noticed that they soon die. They thus came to the conclusion that their pronounced death in the peel is a result of the oil liberated during the formation of the egg cavity.

Hood published an account of the oil content of Florida oranges at various periods during the harvest time and determined the oil value of the peel. Thereby the fact came to light that conditions of climate and culture greatly influence the oil content of the fruit. Only when the fruit is fully ripe does the peel contain its highest percentage of oil.

According to the analysis of different workers, the volatile oils in Citrus rind consist of more than 90% terpene lemonene which has comparatively little or no odour, and from 4-6% aldehyde citrale which is the chief odourous constituent of the oil.

Now, a fraction of the essential oil is of oxygenated nature. The main constituent is terpene which on oxidation yields resin. When a section is made in the rind through an oil chamber and left exposed to the air for one or two days, the oil in the chamber tends to thicken and gradually forms an elastic skin.

It is true that when a fly pierces the rind in the act of oviposition its ovipositor usually ruptures one or more oil chambers and the oil gains

access to the eggs which are slightly affected. The oil cannot possibly affect the larva as the average incubation period (during the summer) is about 2 days. This period is long enough to dry up the oil.

Furthermore Hood's work and also Von Sock's show clearly that the amount of oil increases gradually with the ripening of the fruits and we might well anticipate, in accordance with Back and Pemberton's view, that the mortality of the larvae also increases with the ripening of the fruits. On the contrary, the mortality of the larvae in ripe fruits is decidedly much lower than the uripe ones.

We can conclude therefore that the oil exhibits no obvious indications of having any effect on the larvae in their natural habitat.

(2) The glucosides

The main glucoside in the rind of Citrus fruits is hesperidin. It was discovered by Lebreton (1828) and studied by Hoffmann (1876). It

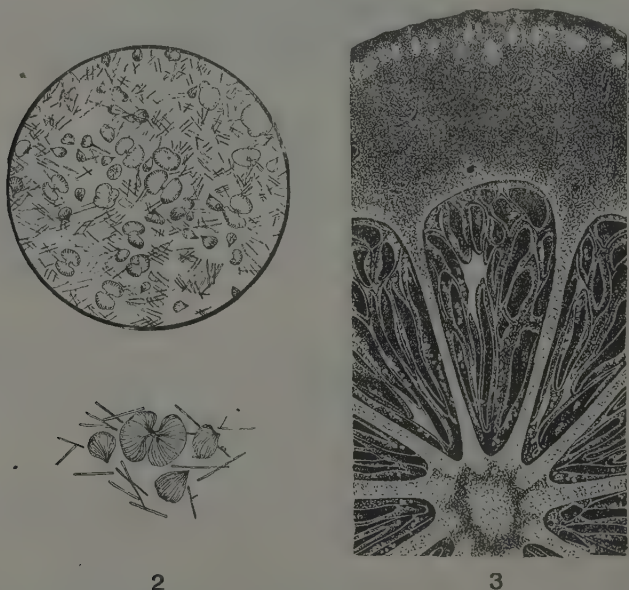


Fig. 2 : Hesperidin crystals highly magnified. — Fig. 3 : A cross-section through a Citrus fruit (the hesperidin is shown as small white spots).

has been found in the rind and pulp of different Citrus fruits, and in the pith, bark, leaf and flowers of oranges.

Properties and behaviour of hesperidin

It consists of colourless, odourless and tasteless needle-shaped crystals

(fig. 2), hardly soluble in water and alcohol, insoluble in ether, chloroform and benzol, but more soluble in acetic acid. It is easily soluble in alkalies, giving a yellow colour.

It is always soluble in the cell sap of the living tissues and separates out on the removal of water from the cell. If on the other hand the tissues containing hesperidin are pressed and the liquid is left to dry up, no hesperidin crystals are formed.

On adding absolute alcohol to some slices of oranges, and leaving them for a few days, the crystals of hesperidin will appear (fig. 2). They are seen in big quantities in the core of the fruits and also in the white rind (fig. 3).

If a section is made through an egg-chamber in the rind, it could be seen that the surface of the puncture is covered with hesperidin crystals which dissolve quickly in caustic soda giving a bright yellow colour (Plate, fig. 1). The aggregation of these crystals round the cut surface of the rind led us to believe that they might form a mechanical barrier for the newly hatched larvae, through which they could not burrow their way through to the pulp.

The quantitative study of hesperidin in different kinds of Citrus fruits might therefore yield important information.

Methods of extraction

The method used by James B. McNair is as follows.

Cut and bruised oranges are covered with dilute alcohol, with potassium hydroxide added in excess to neutrality. The liquid is left for two days and then acidified by dilute hydrochloric acid. The precipitate is boiled with acetic acid for a few minutes; on standing hesperidin crystals separate. We tried this method repeatedly but could not succeed in extracting it. Better results were obtained by leaving the tissues in absolute alcohol for a few days, then replacing it with 60% alcohol to which a few drops of potassium hydroxide was added, leaving for about twelve hours and filtering. The filtrate was received in a flask containing some hydrochloric acid. On standing for a few days hesperidin crystals precipitated.

The foregoing method of extraction was found to be very expensive, so we had to replace it by the following method which gave satisfactory results.

The peel of the fruits was first dried in an oven whose temperature did not exceed 60°C. Drying it at 100°C did not answer the purpose as hardly any hesperidin could be extracted. Then it was ground into a fine powder to which 70% alcohol was added and left for a few days to remove the colouring matters. After that the powder was again dried at 60°C and then extracted with 70% alcohol to which 1% potassium hydroxide was added. The alkaline extract was then acidified with dilute hydrochloric acid and left for a few days when hesperidin was precipitated.

For our purpose it was advisable to concentrate on hesperidin contents of the rind of Egyptian lime, common acid lemon, common Egyptian oranges and common Egyptian tangerines.

The data shown in Table V are the mean result of analysing 25 lots of 100 grs. of powdered peel of each of the above mentioned varieties of Citrus rind taken in the middle of August when the fruits are not mature and also in the middle of December when they are fully ripe.

TABLE V

VARIETY OF FRUIT	PERCENTAGE OF HESPERIDIN	
	August	December
Egyptian lime.....	0.10	0.06
Common acid lemon.....	0.25	0.10
Common Egyptian oranges.....	0.30	0.16
Common Egyptian tangerines.....	0.24	0.19

It will be seen from the analysis that the Egyptian lime, which is never infested by the fruit fly has less hesperidin than the others. Common acid lemon which also is not attacked has less than the orange and tangerine which are attacked.

The amount of hesperidin present in the rind of Citrus fruits has therefore no correlation with the rate of the fruit-fly infestation.

Note: We may take this opportunity of mentioning that we also found hesperidin in the leaves of Citrus trees (Plate, fig. 2). It is more abundant in the young ones and absent in the old leaves (Plate, fig. 3). The star shaped pustules of hesperidin could be clearly seen if the leaves were boiled for a few minutes in water (Plate, fig. 4). It was also noticed that if a leaf is cut by a razor in the middle and left for one hour and then boiled, the crystals would aggregate heavily round the slit (Plate, fig. 5).

If a name is scratched by a pin on the surface of the leaf which is then boiled and placed in 70 % alcohol, the name will appear by the aggregation of the crystals round the scratch.

Data relating to this subject will be published later.

(3) Pectins

Pectic substances occur in plants in association with the cellulose of the cell walls. They are found chiefly in the middle lamella as cementing and

incrustating substances. They occur in great abundance especially in the outer portion of the cell walls of the mesocarp of the peel.

The main portion of the pectic substances occurring in the peel is nearly insoluble in water and can be brought into solution by long continued boiling with water and more quickly by hot dilute mineral acids.

The hydrated pectin obtained by extraction with hot water consists mainly of two substances : (a) a polysaccharine (l-araban), (b) the calcium magnesium salt-pectic acid.

At this point we may now proceed to consider the amount of pectic substances in the peel of different kinds of the most common Citrus fruits in this country viz :

(1) Egyptian lime, (2) common acid lemon, (3) grape fruit, (4) sweet lime, (5) bitter oranges, (6) common Egyptian oranges, (7) Java oranges, (8) navel oranges, (9) sugar oranges, and (10) common Egyptian tangerines.

Method of procedure

In the middle of every month starting from August and ending in April, samples of 50-100 fruits of the above-mentioned varieties were collected at random, one or two from each tree of an orchard in the Barrage. To find out whether the climatic conditions have any bearing on the amount of pectins present in the peel, four kinds of Citrus fruits were collected from Matâna right in the south of Upper Egypt and four from Kurashia in the middle of the Delta. The varieties of fruits taken from the latter two places were common Egyptian oranges, Java oranges, navel oranges and common Egyptian tangerines. As soon as the fruits arrived in the laboratory the outer coloured part of the peel was shaved off by razors leaving only the white portion (the egg masses are laid in this part of the peel) which was again taken off gently in such a manner that no pulp would come out attached to it. Then, the white peel was cut into very small pieces and kept in 95 % alcohol for seven days to remove the colouring matter. After that the peel was squeezed out of the alcohol by means of a hydrolytic press which left it almost dry. Again 70 % alcohol was added to it and it was left for another seven days and squeezed dry again. It was then completely dried in an oven at a temperature not exceeding 60°C. Higher temperature disintegrated the pectins. It was then ground into a fine powder and sieved in a 0.5 mm. sieve. Finally the powder was placed in glass pans and left in desiccators over calcium chloride until the weight became fixed.

Methods of determination

The methods used for the determination of pectin in the peel of citrus fruits may be classified as physical and chemical methods.

(a) *The physical method*

One gram of each of the 10 powdered peels was placed in a 250 cc. flask with 100 cc. of hydrochloric acid whose pH value was 1.4 and heated in a water bath for 20 minutes at a temperature of about 90° C. and left to cool. A known quantity (7 cc.) of the pectin peel solution was then introduced into an Ostwald viscosimeter (fig. 4) and sucked up at (fig. 4a) until the liquid rose above the mark (fig. 4c). The time occupied by the liquid in flowing down from (fig. 4c) to the lower mark (fig. 4d) was noted.

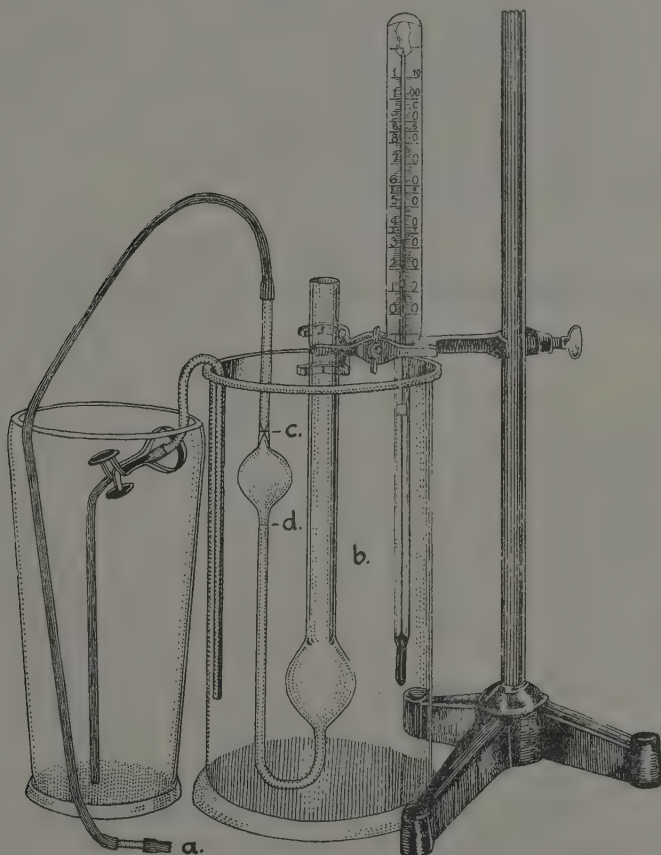


Fig. 4 : Ostwald viscosimeter

If

n = coefficient viscosity of the peel extract,

n_0 = coefficient viscosity of the standard liquid at a given temperature (distilled water at 30° C.),

S = specific gravity of the peel extract (at 30° C.),

S_0 = specific gravity of a standard liquid (distilled water in 30° C),

t = time of flow of the peel extract (in seconds),

t_0 = time of flow of a standard liquid (distilled water),

then the corresponding values for any liquid are related to each other by means of the following equation :

$$n = n_0 \frac{S t}{S_0 t_0}$$

As the viscosity changed very rapidly with the temperature, it was essential that it should be kept constant. This was achieved by placing the viscosimeter in a water bath at a constant temperature of 30° C. (fig. 4b).

The mean value for the coefficient of viscosity calculated for different peels of fruits collected on the 15th of October and also on the 15th of November are given in Table VI.

TABLE VI

VARIETY OF FRUIT	COEFFICIENT OF VISCOSITY	
	15.10 1943	15.11 1943
Egyptian lime.....	56.8	56.8
Common acid lemon.....	25.6	17.4
Grape fruit	7.6	7.5
Sweet lime of Egypt.....	24.2	21.0
Bitter oranges.....	13.8	16.6
Common Egyptian oranges.....	12.4	10.6
Java oranges.....	18.0	13.4
Navel oranges.....	16.6	11.7
Sugar oranges.....	12.4	11.5
Common Egyptian tangerines	11.7	16.1

It can be gathered from examining the above data (Table VI) that :

(1) The coefficient of viscosity of grape fruit is almost equal in October and November (the outcome of this could not be proved as the grape fruit is infested in November and not in October).

(2) The figure for the sweet lime is higher than that of the common acid lemon in November and it is known that during that month the former can be infested while the latter is not.

(3) Common tangerines have the same coefficient of viscosity in Octo-

ber when they are not attacked, as the navel oranges in November when they are infested.

We can conclude therefore that there is no co-ordination between the infestation of the fruits and the coefficient of viscosity of the peel extract.

b. Chemical methods

The literature contains many chemical methods for the determination of pectins. The oldest method of all is the precipitation of pectin from its solution as a gelatinous mass by means of concentrated alcohol.

This method was found to be unsatisfactory for it entails the expenditure of large amounts of alcohol which made it very expensive. Precipitating the pectin by means of copper sulphate solution was also tried, but it did not work as it was very hard to rid the pectin from it.

For our purpose, the best method was found to be that of calcium pectate. It consists of adding to the pectin solution $\frac{N}{10}$ sodium hydroxide solution to convert the pectin into sodium pectate. After acidification with hydrochloric acid (20 cc., specific gravity 1.17-1.18, per litre of water), 5% calcium chloride solution was added and the insoluble calcium pectate was finally precipitated.

Method of preparing pectin extract

One gram of each of the ten varieties of Citrus fruit peel, collected and prepared in the same manner as we have described, was placed in a 250 cc. flask with 100 cc. distilled water, and put in a hot water bath and kept for 20 minutes at a temperature of about 95°C, and filtered. The filtrate was put aside, but the precipitate was treated again with hot distilled water. The precipitate was again taken but this time it was treated with 100 cc. hydrochloric acid, whose pH was 1.4, for the same length of time and temperature and then filtered. By this time we had three filtrates, with distilled water and one with hydrochloric acid.

We took 50 cc. of each and placed it separately in a flask and added to every one 500 cc. of $\frac{N}{10}$ solution of sodium hydroxide. At this point it might coagulate into a gelatinous mass to which 20 cc. hydrochloric acid (2%) and finally 75 cc. 5% calcium chloride was added. A precipitate soon appeared which was moss-like in the two water extracts and follicular in the acid one.

It is worthy of note that we only took 50 cc. of each of the filtrates because the ability of the peel to absorb water and retain it, is different in each variety, and to overcome this difficulty an equal volume, 50 cc. of each of the filtrate was taken. The weight of pectin in one gram of the dry peel

TABLE VII
The percentage of pectins in the dry rind of Citrus fruits (taken from the Barrage, 1945-1946)

VARIETY OF FRUIT	AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Egyptian lime.....	20.0	15.8	35.8	21.4	22.0	43.4	16.2	28.4	44.6	18.0	23.6	41.6	22.8	19.8	42.6
Common acid lemon.....	19.0	18.0	37.0	19.4	17.2	36.6	17.6	22.4	40.0	18.8	23.2	42.0	21.8	18.8	40.6
Grape fruit.....	15.8	19.2	35.0	19.6	19.8	39.4	15.2	21.0	39.2	13.4	21.6	35.0	16.8	17.4	34.2
Sweet lime.....	18.2	18.6	36.8	19.8	19.6	39.4	15.0	23.0	38.0	15.0	22.0	37.0	14.4	23.6	38.0
Bitter oranges.....	14.8	18.6	33.4	16.2	19.2	35.4	14.8	22.8	37.6	14.2	19.8	34.0	13.0	20.6	33.6
Common Egyptian oranges..	15.6	20.0	35.6	15.8	19.2	35.0	13.4	22.2	35.6	14.0	20.0	34.0	11.4	20.6	32.0
Java oranges.....	17.2	17.8	35.0	19.0	18.4	37.4	15.8	19.4	35.2	13.0	21.4	34.4	13.6	20.6	34.2
Navel oranges.....	19.2	19.8	39.0	18.6	19.2	37.8	16.0	20.8	36.8	15.1	19.6	34.7	13.4	20.6	34.0
Sugar oranges.....	12.4	21.0	33.4	13.4	19.4	32.8	11.8	21.4	33.2	11.6	20.4	32.0	12.0	20.0	32.0
Common Egyptian tangerines.	18.0	18.0	36.0	18.4	20.0	38.4	15.0	22.0	37.0	11.6	22.0	33.6	11.6	20.0	31.6

VARIETY OF FRUIT	JANUARY			FEBRUARY			MARCH			APRIL		
	A	B	C	A	B	C	A	B	C	A	B	C
Egyptian lime.....	23.2	20.8	44.0	21.8	19.6	41.4	21.2	20.0	41.2	21.2	20.8	42.0
Common acid lemon.....	18.6	22.0	40.6	19.6	19.4	39.0	24.0	20.0	44.0	27.6	17.4	45.0
Grape fruit.....	15.6	19.2	31.8	12.4	21.6	34.0	15.2	16.8	32.0	14.0	14.0	28.0
Sweet lime.....	16.6	21.0	37.6	15.0	21.6	36.6	18.4	20.8	39.2	not available in April		
Bitter oranges.....	15.4	18.6	34.0	12.0	21.0	32.0	12.6	20.0	32.6	10.0	18.0	28.0
Common Egyptian oranges..	13.0	21.0	34.0	13.0	19.0	32.0	16.6	17.4	34.0	16.0	14.0	30.0
Java oranges.....	15.2	19.8	35.0	14.4	18.0	32.4	17.0	17.0	34.0	19.6	11.4	31.0
Navel oranges.....	14.0	19.0	33.0	12.0	20.0	32.0	13.6	19.4	33.0	18.0	13.0	31.0
Sugar oranges.....	14.2	15.8	30.0	11.0	17.0	28.0	12.0	17.0	29.0	15.2	12.8	28.0
Common Egyptian tangerines.	14.6	18.4	33.0	11.0	17.0	28.0	16.0	13.0	29.0	16.0	10.0	26.0

A = Water soluble pectins
 B = Acid soluble pectins
 D = Total pectins

will, therefore, be practically double that obtained from the 50 cc. of the filtrate.

But why, one might here ask, had we two hot water extracts and only one acid extract? In answering this we may here mention that in the second hot water extract there was an appreciable amount of pectin but it became insignificant in the third treatment. In the second acid extract however, the yield of pectin did not account for another treatment.

TABLE VIII

VARIETY OF FRUIT	PERCENTAGE OF WATER CONTENT IN THE FRESH RIND OF CITRUS FRUITS DURING THE MONTHS OF:								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime.....	68	70.4	72.6	72.6	74.3	75	74	73	73
Common acid lemon.....	67	68	71	73.5	75	76	76	79	80
Grape fruit.....	70	72.4	73	74.2	74.6	78	77	77	80
Sweet lime.....	69	71.4	71.5	73	75.5	78	78.4	80	—
Bitter oranges.....	64.5	68	69	71	73.4	76.5	77.2	78	79
Common Egyptian oranges.....	68	68	70	72	73	75	75	77	77
Java oranges.....	71	71.8	72.4	74	74	75	76	77	78
Navel oranges.....	68	72	70.9	74	74	75.5	75.5	76.8	79
Sugar oranges.....	67.4	68.5	69	71	71.5	71.4	71.2	72	72
Common Egyptian tangerines.....	58	62	67	74	75	76	78	78	77

TABLE IX

VARIETY OF FRUIT	PERCENTAGE OF THE TOTAL PECTINS IN THE FRESH RIND OF CITRUS FRUITS DURING THE MONTHS OF:								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime.....	11.4	12.8	12.2	11.4	10.9	11	10.3	9.8	9.6
Common acid lemon.....	12.2	11.7	11.6	11.1	10.1	9.7	9.3	9.2	8.8
Grape fruit.....	10.5	10.8	10.5	9	8.6	7.6	7.8	7.5	5.8
Sweet lime.....	11.4	11.2	10.8	10	9.3	8.3	7.9	7.8	—
Bitter oranges.....	11.8	11.3	11.6	9.8	8.9	8	7.3	7.1	5.8
Common Egyptian oranges.....	11.4	11.2	10.6	9.5	8.2	8.5	8	7.8	6.9
Java oranges.....	10.1	10.5	9.7	8.9	8.8	8.7	7.7	7.8	6.8
Navel oranges.....	12.4	10.5	10.7	9	8.8	8.7	7.8	7.6	6.5
Sugar oranges.....	10.8	10.3	10.3	9.1	9.1	8.5	8	8.1	7.8
Common Egyptian tangerines.....	15.1	14.5	12.2	8.7	7.8	7.9	6.1	6.3	5.9

As we were dealing with very minute quantities of pectin, care had to be taken of the weight of filter papers. At first they were placed in a drying oven at 98° C. for 48 hours and then were taken and put over calcium chloride in desiccators till their weight became fixed. After filtering, the filter paper with the precipitate was treated again in the same manner.

It should be noticed that the precipitate had to be washed carefully with hot distilled water until there was no trace of the calcium chloride that was used for precipitating the pectin. This could be tested by adding to the washing water filtrate a few drops of silver nitrate solution.

The average percentage of both water and acid-soluble pectin together with the total pectins of 30 samples of each of our ten varieties of Citrus fruits are shown in Table VII.

TABLE X

VARIETY OF FRUIT	COMPARATIVE CONCENTRATION OF PECTINS IN THE WATER CONTENT OF THE RIND OF CITRUS FRUITS $\times 100$ DURING THE MONTHS OF :								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime.....	16.7	18	16.8	15.7	14.6	14.6	13.9	13.4	13.1
Common acid lemon.....	18.2	17.2	17.1	15.1	13.4	12.7	12.2	11.6	11.1
Grape fruit.....	15	14.9	14.5	12.1	11.5	9.7	10.1	9.7	7.2
Sweet lime.....	16.5	15.6	15.1	13.7	12.3	10.6	10	9.8	—
Bitter oranges.....	17.8	16.6	16.8	13.8	12.1	10.4	9.4	9.1	7.2
Common Egyptian oranges.....	16.7	16.4	15.1	13.1	11.2	11.3	10.6	10.1	8.7
Java oranges.....	14.2	14.6	13.4	12	11.8	11.6	10.1	10.1	8.7
Navel oranges.....	18.2	14.5	15	12.1	11.9	11.5	10.3	9.8	8.3
Sugar oranges.....	16	15	14.9	12.8	12.7	11.9	11.2	11.1	10.8
Common Egyptian tangerines.....	26	23.3	18.2	11.7	10.3	10.3	7.8	8	7.6

From Tables VII and VIII we can calculate :

- (1) The percentage of total pectins in the fresh peel (Table IX).
- (2) The comparative concentration of the total pectins in the water content of the peel (Table X), by dividing the percentage of the total pectin by the percentage of the water content of the peel (the figures in Table X are multiplied by 100 for convenience).

It follows from Table X that :

- (1) The concentration of total pectins decreases gradually towards maturation.
- (2) The variation in the pectin concentration for each month is not very great with the exception of the Egyptian lime, the common acid lemon and the common Egyptian tangerines.

(3) The pectin concentration of the tangerines drops suddenly in November.

It is necessary at this stage to refer briefly to the percentage of infestation in different varieties of Citrus fruits in some parts of the country during 1939-1941 seasons.

In Upper Egypt, Assiut, Fayoum and Giza were examined, and no trace of infestation in any variety of Citrus fruits could be found except at the (Faculty of Agriculture in Giza where the infestation appeared only in April in grape fruit and bitter oranges, the percentage being 21 and 19 respectively. No other varieties were infested.

In Lower Egypt there was no infestation at Alexandria or Edfina, but at the Barrage, and Benha and Shebin 'El-Kom, it was as is shown in Table XI.

TABLE XI

VARIETY OF FRUIT	MONTH							TOTAL
	VIII	IX	X	XI	XII	I	II	
Egyptian lime.....	—	—	—	—	—	—	—	—
Common acid lemon.....	—	—	—	—	—	—	—	—
Grape fruit.....	—	—	—	1.0	0.5	—	—	1.5
Sweet lime.....	—	—	—	0.5	—	—	—	0.5
Bitter oranges.....	—	—	—	—	—	—	—	—
Common Egyptian oranges....	—	—	—	1.5	1.5	—	—	3.0
Javá oranges.....	—	—	—	1.0	1.5	—	—	2.5
Navel oranges.....	—	—	—	1.0	1.5	—	—	2.5
Sugar oranges.....	—	—	—	0.5	—	—	—	0.5
Common Egyptian tangerines..	—	—	—	3.0	2.0	—	—	5.0

All the fruits were collected by the end of February. No orchard that had all the above mentioned varieties was available up to the end of April. It was however possible to find some common Egyptian oranges in Minofia province in May where the average attack was about 20 %.

It would therefore appear from the data already given that there is some correlation between the concentration of total pectins and the rate of infestation. Neither the water nor the acid-soluble pectins, each taken singly, seem to express this correlation.

But how can we account for the lack of infestation in Upper Egypt? That the fruit fly is present and can survive there is shown by the heavy infestation of peaches wherever it is grown. The pectin analysis and the water content of the peel of the fruits collected from Upper Egypt do not show appreciable difference from those grown in Lower Egypt.

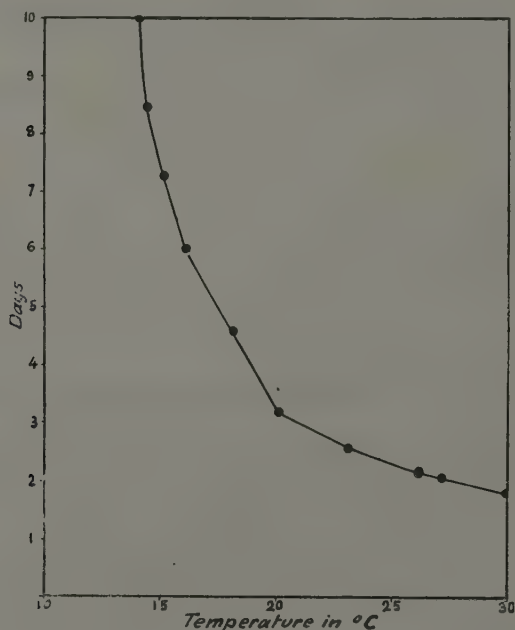
This suggests that the weather conditions might have some bearing on the attack.

Now, falling back on the method of egg laying of the fly, it is shown that the eggs are deposited in chambers punctured by the ovipositor in the white portion of the peel. It is evident that if the peel round the puncture dries up before the hatching of the eggs, the larvae produced will not be able to penetrate to the pulp owing to the hard and horny consistency of the walls of the puncture.

The drying up of the puncture must evidently depend mainly on :

(1) The drying capacity of the air or, as it is better expressed, the saturation deficiency which is the number of millibars by which the partial

CURVE I



pressure of the water vapour actually present falls short of the saturation pressure at the same temperature (Table XII). (If the relative humidity and the temperature is known (Table VII), the saturation deficiency can be found by means of special Tables).

TABLE XII
The average temperature and relative humidity in different localities (1924-1934)

LOCALITIES	January		February		March		April		May		June		July	
	T	H	T	H	T	H	T	H	T	H	T	H	T	H
Aswan	15	46	17	41	21	34	26	39	30	31	33	29	33	29
Quena	15	68	17	62	21	50	26	39	29	37	32	38	32	40
Assiut	12	69	13	62	17	54	22	42	26	36	29	37	30	41
Beni-Suef	12	73	14	70	17	63	20	54	24	50	26	60	27	69
Fayoum	11	75	13	71	16	64	20	54	25	50	28	52	29	56
Giza	11	78	13	71	16	68	20	60	23	54	26	56	27	62
Benha	13	87	14	81	16	79	20	68	23	63	27	66	28	73
Zagazig	11	81	12	78	15	75	19	66	23	60	26	61	27	67
Alexandria	13	77	14	76	16	72	18	70	21	71	24	72	26	74

LOCALITIES	August		September		October		November		December	
	T	H	T	H	T	H	T	H	T	H
Aswan	33	30	31	32	28	35	22	41	17	45
Quena	32	43	30	53	27	56	22	60	17	64
Assiut	29	46	26	56	24	62	18	67	14	69
Beni-Suef	28	74	24	76	23	72	18	73	14	77
Fayoum	28	59	26	64	23	67	18	72	13	76
Giza	27	67	24	72	22	74	18	77	13	79
Benha	28	77	25	79	23	79	19	82	15	85
Zagazig	26	72	24	79	22	80	19	82	13	83
Alexandria	26	74	26	71	23	72	20	75	15	77

T = Temperature in °C
H = Relative humidity

TABLE XIII

LOCALITIES	AVERAGE SATURATION DEFICIENCY OF THE AIR IN DIFFERENT LOCALITIES, TAKEN OVER TEN YEARS (1924-1934) DURING THE MONTHS OF :											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Aswan	6.87	8.49	12.17	15.46	21.61	26.57	26.57	26.27	22.77	16.57	11.36	7.99
Quena	4.07	5.59	9.27	15.46	21.54	22.02	21.32	20.02	14.71	11.87	7.83	5.29
Assiut	3.23	4.24	6.69	11.33	16.16	18.64	18.51	15.49	11.06	8.5	5.03	3.68
Beni-Suef	2.83	3.48	5.39	7.96	11.25	10.06	8.27	7.17	5.35	5.86	4.13	2.78
Fayoum	2.37	3.24	4.31	7.96	11.82	13.67	13.14	11.57	9.16	6.76	4.33	2.64
Giza	2.07	3.14	4.00	6.86	9.66	11.06	10.07	8.77	6.15	5.13	3.53	2.34
Benha	1.54	1.48	2.51	5.56	7.76	9.17	7.37	6.57	5.02	4.26	2.92	1.87
Zagazig	1.77	2.33	3.07	5.52	8.36	9.76	8.77	7.06	4.75	3.83	2.92	1.94
Alexandria	2.54	2.88	3.81	4.63	5.37	6.35	6.46	6.46	7.36	5.86	4.36	2.87

TABLE XIV

VARIETY OF FRUIT	INDEX OF THE FRUIT-FLY ATTACK ON CITRUS FRUITS IN ASSIUT DURING THE MONTHS OF:								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime	490.9	435.6	336	361.1	Average temperature 14 °C	Average temperature 12 °C.	Average temperature 13 °C.	483.7	415.2
Common acid lemon.	535.0	416.2	342	347.3				418.7	351.8
Grape fruit	441.0	360.5	290	278.3	Average temperature 14 °C	Average temperature 12 °C.	Average temperature 13 °C.	350.1	228.2
Sweet lime	485.1	377.5	302	315.1				353.7	—
Bitter oranges.	523.3	401.7	336	317.4	Average temperature 14 °C	Average temperature 12 °C.	Average temperature 13 °C.	328.5	228.2
Common Egyptian oranges.	490.9	396.8	302	301.3				364.6	228.1
Java oranges.	417.4	353.3	268	276.0	Average temperature 14 °C	Average temperature 12 °C.	Average temperature 13 °C.	364.6	275.7
Navel oranges.	535.0	350.9	300	278.3				353.7	263.1
Sugar oranges.	470.4	363.0	298	294.4	Average temperature 14 °C	Average temperature 12 °C.	Average temperature 13 °C.	400.7	342.3
Common Egyptian tangerines.	764.4	563.8	364	269.1				288.8	240.9

(2) The length of time during which the puncture is exposed to the drying agency of the air. This is obviously the incubation period of the eggs; if the eggs hatch, as they do in the summer after two days, the puncture will be exposed for a shorter time than that in winter which is exposed for eight days or so.

It seems therefore that the main factors limiting the infestation of Citrus fruits are :

- (1) The percentage of the total pectins in the fresh peel.

TABLE XV

VARIETY OF FRUIT	INDEX OF THE FRUIT-FLY ATTACK ON CITRUS FRUITS IN FAYOUM DURING THE MONTHS OF :								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime	385.7	361.8	294.0	312.4	Average temperature 13 °C.	Average temperature 11 °C.	Average temperature 13 °C.	385.9	332.7
Common acid lemon.	420.4	345.7	299.2	300.4				344.0	281.9
Grape fruit	346.5	299.4	253.7	240.7				279.3	182.8
Sweet lime	381.1	313.5	264.2	272.6				282.2	—
Bitter oranges	411.1	333.6	294.0	274.6				262.0	182.8
Common Egyptian oranges	385.7	329.6	264.2	260.6	Average temperature 13 °C.	Average temperature 11 °C.	Average temperature 13 °C.	290.8	225.0
Java oranges	328.0	293.4	234.5	238.8				290.8	220.9
Navel oranges	420.4	291.4	262.5	240.7				282.2	210.8
Sugar oranges	369.6	301.5	260.7	254.7				319.6	274.3
Common Egyptian tangerines	600.6	468.3	318.5	232.8				230.4	193.0

TABLE XVI

VARIETY OF FRUIT	INDEX OF THE FRUIT-FLY ATTACK ON CITRUS FRUITS IN GIZA DURING THE MONTHS OF :								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime	292.2	264.6	240.2	254.3	Average temperature 13 °C.	Average temperature 11 °C.	Average temperature 13 °C.	321.6	286.9
Common acid lemon	318.5	252.8	230.2	244.6				278.4	243.0
Grape fruit	262.5	218.0	207.3	196.0				232.8	157.6
Sweet lime	288.7	229.3	25.9	221.9				235.2	—
Bitter oranges	311.5	244.0	240.2	222.5				218.4	157.6
Common Egyptian oranges	292.2	241.0	215.9	212.2	Average temperature 13 °C.	Average temperature 11 °C.	Average temperature 13 °C.	242.4	194.9
Java oranges	248.5	214.6	191.6	194.4				242.4	190.5
Navel oranges	318.5	213.1	214.5	196.0				235.2	181.7
Sugar oranges	280.0	220.5	213.0	207.3				266.4	236.5
Common Egyptian tangerines	455.0	342.5	260.2	189.5				192.0	166.4

(2) The percentage of the water content of the peel.

(3) The saturation deficiency of the air.

(4) The incubation period of the eggs (shown in Curve I). (The temperature of different localities in Egypt is shown in Table XIII).

We have attempted to form a mathematical expression representing the correlation between all these factors and the rate of infestation thus :

$$\frac{\text{percentage of total pectins in the fresh peel}}{\text{percentage of water content of the peel}} \times 100 \times \text{saturation deficiency} \times \text{incubation period of the egg.}$$

TABLE XVII

VARIETY OF FRUIT	INDEX OF THE FRUIT-FLY ATTACK ON CITRUS FRUITS IN BEN HA DURING THE MONTHS OF:									
	VIII	IX	X	XI	XII	I	II	III	IV	
Egyptian lime.....	218.7	207.0	185.9	183.7	195.7	Average temperature 13 °C.	Average temperature 14 °C.	207.0	238.0	
Common acid lemon.....	238.4	197.8	178.2	176.6	179.5			174.0	187.0	
Grape fruit.....	196.5	171.5	160.5	140.3	154.1			147.0	128.1	
Sweet lime.....	216.6	179.4	167.1	158.9	164.8			147.0		
Bitter oranges.....	233.1	190.9	185.9	161.2	162.1			196.5	128.1	
Common Egyptian oranges.....	218.7	188.6	167.1	153.2	150.0			161.5	178.4	
Java oranges.....	186.0	167.9	148.5	140.4	158.1			151.5	154.8	
Navel oranges.....	238.4	166.7	166.0	141.5	159.4			147.0	147.7	
Sugar oranges.....	202.6	172.5	164.9	149.7	170.1			166.5	192.1	
Common Egyptian tangerines.....	340.6	267.9	201.4	136.8	138.0			120.0	135.5	

TABLE XVIII

VARIETY OF FRUIT	INDEX OF THE FRUIT-FLY ATTACK ON CITRUS FRUITS IN ZAGAZIG DURING THE MONTHS OF:								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime.....	257.1	265.2	179.7	183.7	Average temperature 13 °C.	Average temperature 11 °C.	Average temperature 12 °C.	216.5	288.2
Common acid lemon.....	280.2	196.0	174.4	176.6				196.5	244.2
Grape fruit.....	231.0	169.8	155.1	144.0				114.5	158.4
Sweet lime.....	254.1	177.8	161.5	160.3				216.5	—
Bitter oranges.....	273.5	181.2	179.7	161.4				201.1	158.4
Common Egyptian oranges.....	257.1	186.9	161.5	153.2				228.2	195.8
Java oranges.....	218.6	166.4	143.3	140.4				128.2	166.4
Navel oranges.....	280.2	165.2	160.5	141.5				216.5	182.6
Sugar oranges.....	240.4	171.0	159.4	149.7	Average temperature 13 °C.	Average temperature 11 °C.	Average temperature 12 °C.	145.5	267.6
Common Egyptian tangerines.....	400.4	265.6	194.7	136.8				176.8	167.2

This formula gives us a comparative figure, the Index of Infestation. If this figure is above 160 the fruits will be immune, from 160-145 the fruits will resist the attack, below 145 they will yield to the attack. As the threshold of development of the fruit-fly is about 13.5°C (Bödenheimer, 1926) it follows that if the average temperature of the month is below about 14°C, hardly any infestation will take place.

The Index of Infestation for Assiut, Fayoum and Giza in Up-

TABLE XIX

VARIETY OF FRUIT	INDEX OF THE FRUIT-FLY ATTACK ON CITRUS FRUITS IN ALEXANDRIA DURING THE MONTHS OF:								
	VIII	IX	X	XI	XII	I	II	III	IV
Egyptian lime.....	237.1	291.6	255.3	218.2	300.7	Average temperature 13 °C.	Average temperature 14 °C.	305.5	279.0
Common acid lemon.....	258.4	278.6	259.9	209.8	276.0			264.4	236.4
Grape fruit.....	213.0	241.3	220.4	168.2	236.9			221.1	153.3
Sweet lime.....	234.3	252.7	229.5	190.4	253.3			223.4	—
Bitter oranges.....	252.4	268.9	255.3	191.8	249.2			207.4	153.3
Common Egyptian oranges.....	237.1	265.7	229.5	182.0	230.7			230.2	189.5
Java oranges.....	201.6	236.5	203.6	166.8	243.0			230.2	185.3
Navel oranges.....	258.4	234.9	228.0	168.2	245.1			223.4	176.8
Sugar oranges.....	227.2	243.0	226.4	177.9	261.6			253.0	230.0
Common Egyptian tangerines.....	369.2	377.4	276.6	162.6	212.8			182.4	164.0

per Egypt are shown in Tables XIV, XV, and XVI, and that of Benha, Zagazig and Alexandria in Lower Egypt, in Tables XVII, XVIII and XIX.

By examining a big number of Citrus orchards all over the country, it appeared that the infestation is always heavier wherever the trees are dense with narrow spacing. There is hardly any attack on fruits of small trees. The relative density of foliage of two trees standing side by side would greatly affect the microclimatic conditions under them, because of the difference in the air movement.

A striking feature in the behaviour of the fly is its instinct to lay its eggs almost always towards the navel end of the fruits. The outcome of this inborn behaviour is placing the eggs in the best available conditions for the survival of the offspring. It is obvious that the navel end of the fruit is always oblique to the sun's rays, so the evaporation of water from the egg chambers will, therefore, be much less than those produced in the stem end of the fruits.

DISCUSSION

In the light of the data presented we can now proceed to discuss whether it is possible to devise applicable cultural modifications in order to place the fly at a disadvantage.

We have already mentioned the factors governing the rate of attack and it can be easily realised that neither the percentage of pectin nor the incubation period of the eggs at a given temperature is under our control. On the other hand, the conditions that can raise the local relative humidity

of an orchard which renders the fruits more susceptible to infestation, and can be partly interfered with are :

(a) Close spacing of the trees; (b) bad draining; (c) high Nile flood; (d) heavy watering, which will also affect the water content of the peel as has been shown in some orchards in Minofia which was kept without water for two months during the winter, after which it was watered (the percentage of the water content of the peel was accordingly increased from 2-4 %).

SUMMARY

It was thought that the limiting factor in the attack of the fruit-fly, in Citrus fruits, was the acidity of the juice, but detailed analysis of different Citrus fruits did not show any correlation.

The factors were classified into :

(I) Physical factors comprising : (a) the thickness of the rind, and (b) the mechanical resistance of the rind to the puncture of the ovipositor; but there was no co-ordination between the physical factors and the percentage of attack.

(II) Chemical factors consists of : (a) essential oils, (b) glucosides, and (c) pectins.

The limiting factors for the infestation of Citrus fruits were found to be : (a) the percentage of the total pectins in the fresh peel, (b) the percentage of the water content of the peel, (c) the saturation deficiency of the air, and (d) the incubation period of the eggs.

A mathematical expression representing the correlation between all these factors and the rate of infestation has been attempted.

The formula gives us the Index of Infestation; if it is above 160 the fruits will be immune against infestation, from 160-145 the fruits resist the attack, below 145 they will yield to the attack.

The Index of Infestation in different parts of Upper and Lower Egypt is given in Tables.

ACKNOWLEDGMENTS

It is with great pleasure that I express my indebtedness to Prof. Dr. H. Priesner and M. S. El Zoheiry Bey, the previous and the present directors of our Entomological Section, for their interest and helpful guidance. I wish to express my thanks and gratitude to G. Abo El-Fitouh Eff., Senior Chemist, for valuable suggestions, and also to all my colleagues of the Chemistry Section of the Ministry of Agriculture for providing every facility to work in their Laboratories.

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I am further indebted to my assistants: Fouad Faris Eff. for carrying out the sugar, acid and protein analysis of the citrus fruit juices, Amin Ezzat Eff. and Kamel Gamal El Din Eff. for their cooperation in the field work.

I am very grateful to Farid Abdel Fatah Eff. and Ahmed El Badry Eff., my laboratory assistants, for their perseverance, willingness and devotion to duty.

Finally I should like to thank Ahmed Sherif, Abdel Hassib Abdel El Rahman, and Amin Shihata, my field workers, for collecting and preparing the fruit peel for analysis.

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The Lepidoptera of the Kingdom of Egypt

PART I

(with 7 Plates, 68 Text-Figures, and an Addendum)

by E. P. WILTSHIRE, F.R.E.S.

Contents of Part I

Introduction. — Geography and ecology. — Species or forms new to science. — Species new to Egypt. — Species to be deleted from Egyptian list. — Early stages published here for the first time. — List of species illustrated in this part. — References. — Glossary and explanation of abbreviations. — Systematic list: Nos. 1-250 (Papilionoidea, Hesperioidea, Bombycoidea, Agrotoidea [Agrotidae, Lymantriidae, and Arctiidae, except Nolinae]). — Addendum.

INTRODUCTION

It is high time that Egypt's comparatively limited but most interesting Lepidoptera were reviewed in a single article avoiding the errors of previous lists and including their many omissions. The rich material at my disposal here in Cairo tempts me to attempt this to the best of my ability. The Alfieri and Petroff collections, to which I referred in a briefer article last year, provide the main basis for the list which follows. In addition, however, I have included my own, far fewer, Egyptian captures and observations, and also the more reliable of the records from Egypt to be found in literature. In the few cases where I have not seen a specimen of a species listed, the fact is mentioned. The species are numbered consecutively, and the reasons for deleting certain names from the list are given in the appropriate taxonomic position in parentheses, or in the comment of the species mistaken.

My chief concern has been to produce a list of accurate specific identifications, with appropriate biological and ecological comment where possible. For the latter, the meticulously labelled material of the Alfieri collection has proved a gold-mine ! I have been less concerned with names of variations, aberrations and seasonal forms, but I have discussed these in cases where previous literature had not already rendered such notes redundant, and where it was possible.

I have endeavoured to consult all the available specialists, for the different families of the fauna, so as to be able to give the latest and most authoritative

order, nomenclature and identifications. Some groups unfortunately are without an authority; in some others present world conditions have hampered consultation. I regret therefore that the list as a whole is not consistent throughout in this respect. At least 150 microscopic preparations have been made; these have been compared with the relevant literature or have been the subject of copious correspondence. All thanks are therefore due to these specialists, and also to Mr. Anastase Alfieri for letting me treat his beautifully-set collection in this way. Among those consulted I am particularly indebted to Messrs. Boursin, Evans, and Stempffer; some other helpers and authorities are named under the relevant family-heading in the systematic list.

Without such precautions even the best entomologists may be guilty of first-class errors: e.g. the confusion of *Utetheisa pulchella* L. and *lotrix* Cr. (Nos. 249 and 250 in the list below), to mention only one error occurring in all previous Egyptian lists. Even taking every care, an author can hardly be expected to anticipate the discoveries and knowledge of the following generation in full, and I can hardly have entirely avoided errors, especially since circumstances prevent me from consulting the British Museum collection and from devoting more of my time to the work in hand, to a degree necessary if perfection were aimed at. The handicaps of unsatisfactory communications and amateur status have however been outweighed by the knowledge that the material before me deserves publication, the Egyptian list requires revising, enough original study has been done to interest the entomological world, a list is more useful than scattered notes, and no one but myself is able or willing (nor is likely to be so in the foreseeable future) to undertake the work of producing this list.

For certain photographs of scenery, I am indebted to J. Shabetai Effendi, Mr. A. Alfieri, and Prof. Oliver.

GEOGRAPHY AND ECOLOGY

According to the rainfall regime the Kingdom of Egypt may be divided into three zones:

(1) A narrow coastal strip in the north-west. Winter rainfall, maximum: about ten inches per annum.

General character: Mediterranean steppe and dunes.

Chief localities: Sollum, the Mariout [see Plate III, figs. 1 and 2], Alexandria (Ramleh).

The bulk of Petroff's Mariout captures were made at Ikingi-Mariout.

(2) A broad desert strip covering most of the country, reaching the north coast in the East (e.g. at Port-Said). Winter rainfall, maximum: three inches per annum; rainfall often negligible over vast areas except at intervals of several years.

Character: Sub-Tropical desert, with vegetation restricted to depressions and wadis.

Chief localities :

(a) West of the Nile and south of the Qattara Depression is the Libyan Desert, and its fauna has been sampled in and around the oases mentioned below [see Plate IV, fig. 1], and also, on its fringe, near the Giza Pyramids, near Cairo.

(b) East of the Nile and south of the Delta is the faunistically richer, hillier, Eastern Desert or Arabian Desert.

Here belong : Heliopolis, Suez Road, Gebel Mokattam, Wadi Tih and Wadi Digla [see Plate II, fig. 2] (both debouching at Maadi, south-east of Cairo), Wadi Hof (including Ougret el Sheikh), and Wadi Gerrawi (both debouching near Helwan, south of Maadi), Tourah (between Maadi and Helwan), Wadi Rishrash, Wadi Murrah, etc. ; maritime localities of the same area are Bir Odeib (Gulf of Suez) and Hurgada (Red Sea) ; despite their seaside situation the latter are Saharan rather than Mediterranean in character, differing from typical Saharan habitats only in the smaller range of temperature and heavier night dews ; Sinai [Plate IV, fig. 2, and Plate V, fig. 1] belongs here too, but the high mountains in the south of the peninsula make it a special Eremic habitat, faunistically close to the heights of Midian (Arabia Petraea). The summits have stormy winters with some snow.

(3) The Tropical Monsoon area in the extreme South-East, South of the Tropic of Cancer. Summer rains in July and August.

Character: The northernmost outlier of the Abyssinian quolla, xerophilous woods of park and savannah communities (Atbai plant zone) ; in Egypt this flora occurs only on mountains.

Locality : Gebel Elba [see Plate V, fig. 2].

Ecologically however a further radical division is necessary, that between oasis and desert. The oasis biotope provided by the Nile valley [see Plate II, fig. 1] bisects the second of the above rainfall zones and provides the Eastern boundary of the first. The third rainfall zone however does not approach the Nile in Egypt proper. From the Delta southwards to Aswan this oasis biotope is continuous, but at Aswan, just north of the Tropic, it stops, and from Aswan to just north of Khartoum, in the Sudan, the Nile's banks are Tropical desert of the most arid sort. This gap in riverain cultivation and irrigation, and the prevailing north wind, doubtless have prevented and still prevent the infiltration of many Tropical species. Principal localities in this oasis biotope, from North to South : the Delta, with its provinces Beheira, Gharbia, Menufia, Daqahlia, Qaliubiya and Sharqiya ; Cairo and Giza ; and, in Upper Egypt : Beni Suef, El Minya, and Aswan.

Two outlying oases are watered from the Nile, the Fayoum in the West and the Canal Zone in the North-East (localities in the latter: Ismailiya, Geneifa). The notable oases in the Libyan Desert are: Siwa, Baharia [see Plate IV, fig. 1], Farafra, Dakhla and Kharga. These five and the two outlying oases are more Eremic in character than the Nile valley and Delta. The water-supply of the five is of course much smaller and being brackish is not always fully utilised. The intense cultivation, with exotic importations of crop and tree, in the Nile valley and Delta, rather militates against a rich primary insect fauna; this explains why in many cases Eremic oasis species are represented chiefly by specimens from the seldom-visited remote oases.

It is hoped that a zoogeographical discussion of Egypt's Lepidopterous Fauna will be included in Part II of this work, in next year's Bulletin, and that this part will also continue the systematic list from species No. 251 onwards (*Nolinae*, *Geometridae*, etc.). Discussions of certain zoogeographical points however appear scattered through the list of this Part, e.g. under Nos 107, 118, and in parenthesis between Nos. 120 and 121, and again between Nos. 160 and 161, also under Nos. 136 and 176.

SPECIES AND FORMS NEW TO SCIENCE

The following names are here published for the first time. I thought it useful to include one or two new forms from outside Egypt, closely related to forms from inside.

No. 29. *Iolana alfierii* spec. nov., South Sinai (Egypt); No. 96a. *Anepia imitaria petroffi* subspec. nov. (? Egypt) No. 121 *Bryonima sinaica* spec. nov., South Sinai (Egypt); No. 132. *Sidemia beduina* spec. nov., North Sinai (Egypt); No. 188. *Thalerastria alfierii* spec. nov., South Sinai (Egypt); No. 188a. *Thalerastria alfierii erythra* subspec. nov. (Arabia); and No. 188b. *Thalerastria rex* spec. nov. Asir (Arabia).

Also two more in the Addendum.

SPECIES NEW TO EGYPT

Forty-three species were mentioned on pp. 15-16 of last year's Bulletin as new to Egypt; forty of these are listed in this Part, being numbered as follows: 15, 17, 77, 90, 91, 95, 100, 104, 107, 108, 109, 114, 117, 119, 123, 124, 125, 126, 128, 135, 136, 147, 152, 153, 156, 163, 177, 186, 190, 191, 192, 193, 204, 214, 215, 217, 222, 226, 228 and 230.

The other three belong to families left till later.

In addition, this Part introduces as new to Egypt the following thirty-four species:

No. 2. *Danaïs dorippus*; No. 4. *Charaxes hansali*; No. 13. *Anthene amarah*; No. 29. *Iolana alfierii*; No. 40. *Colotis chrysonome*; No. 41.

Colotis danae eupompe; No. 42. *Colotis evenina casta*; No. 47. *Sarangesa phidyle*; No. 48. *Gomalia elma albofasciata*; No. 49. *Carcharodus stauderi ambigua*; No. 50. *Carcharodus alceae*; No. 52. *Pelopidas thrax*; No. 58. *Lasiocampa josua*; No. 61. *Lambessa pungeleri*; No. 84. *Agrotis sardzeana*; No. 118. *Eumichtis lea*; No. 120. *Aporophila cinerea*; No. 121. *Bryomima sinaica*; No. 131. *Sidemia discordans*; No. 132. *Sidemia beduina*; No. 133. *Catamecia jordana*; No. 137. *Arsilonche albovenosa*; No. 157. *Pseudamathes volloni*; No. 161. *Phragmitiphila typhae*; No. 167. *Leptosia velox*; No. 170. *Leptosia griseimargo*; No. 176. *Porphyrinia nives*; No. 178. *Porphyrinia* (?) *virginalis*; No. 184. *Ozarba variabilis*; No. 185. *Ozarba timida*; No. 188. *Thalerastris alfierii*; No. 197. *Microxestis wutzdorffi*; No. 229. *Acantholipes circumdatus*; and No. 239. *Raparna conicephala*.

Also 26 more in the Addendum.

SPECIES TO BE DELETED FROM THE EGYPTIAN LIST

Seven species, plus two « probables », were named on page 14 of last year's Bulletin as previously wrongly recorded from Egypt; their case is discussed under, or in parenthesis, after, species Nos. 99, 116, 120, 122, 133, 134, 135, and 158.

A further seven species must also be deleted from the Egyptian list, for reasons discussed under or after the numbers given after their names *Tarucus theophrastus* F. (?) (20), *Philotes baton* Berg. (28), *Lycaena argus* L. (25), *Pelopidas mathias* F. (52), *Derthisa trimacula* Schiff. (118), *Porphyrinia wollastoni* Roths. (177), *Porphyrinia minima* Guen. (197), and *Armada hueberi* Ersch. (234). Of these, *theophrastus* may possibly be discovered in Upper Egypt one day, and *minima* was not recorded in the principal lists.

Also two more in the Addendum.

EARLY STAGES PUBLISHED HERE FOR THE FIRST TIME

The hitherto unrecorded early stages are described, illustrated or discussed, in this Part, of the following species: 56. *Chondrostega longespinata*; 62. *Anadiasa undata*; 64. *Dendrolimus alfierii*; 54. *Caradrina melanurina*; 214. *Scodionyx mysticus*, and two more in the Addendum.

Notes on the foodplant and life-cycle in Egypt are also given of many other species.

LIST OF SPECIES ILLUSTRATED IN THIS PART

The following appear in the coloured Plate I:

Fig. 1. *Iolana alfierii* spec. nov., ♂; Fig. 2. *Iolana alfierii* spec. nov., ♂, underside; Fig. 3. *Lambessa pungeleri* Stertz., ♂; Fig. 4. *Lambessa decolorata* Klug, ♂; Fig. 5. *Lambessa decolorata* Klug, ♀; Fig. 6. *Dendrolim-*

mus alfierii Andres-Seitz, ♂; Fig. 7. *Dendrolimus alfierii* Andres-Seitz, ♀; Fig. 8. *Dendrolimus alfierii* Andres-Seitz, larva; Fig. 9. *Agrotis herzogii* Rebel, ♂; Fig. 10. *Agrotis sardzeana* Brandt, ♀; Fig. 11. *Autophila pauli* Boursin, ♂; Fig. 12. *Autophila cymaenotaenia orthotaenia* Wilts., ♂; Fig. 13. *Pseudamathes volloni* Lucas, ♀; Fig. 14. *Leucanitis picta radapicta* Stgr., ♀; Fig. 15. *Syneda habibazel* Dumont, ♂.

The following appear in the half-tone Plates VI and VII :

Plate VI : Figs. 1 and 2. *Anadiasa undata* Klug, larvae; Fig. 3. *Nadiasa acaciae* Klug, larva; Fig. 4. *Nadiasa acaciae* Klug, eggs, cocoon, and moth (♀); Fig. 5. *Cucullia efflatouni* nov. spec., ♀ (Addendum); Fig. 6. *Antitype juditha* Stgr., ♂; Fig. 7. *Bryomima sinaica* spec. nov., ♂; Fig. 8. *Sidemias discordans* Boursin, ♂; Fig. 9. *Sidemias beduina* spec. nov., ♂; Fig. 10. *Bryophila ? paulina* Stgr., ♀; Fig. 11. *Caradrina (Hymenodrina) aspersa* Ramb., ♀; Fig. 12. *Thalerastris alfierii* spec. nov., ♂.

Plate VII : Fig. 1. *Lasiocampa serrula aegyptiaca* Ob., ♂; Fig. 2. *Lasiocampa serrula aegyptiaca* Ob., ♀; Fig. 3. *Lasiocampa serrula palaestina* Stgr., ♀; Fig. 4. *Lasiocampa serrula davidis* Sgr., ♂; Fig. 5. *Lasiocampa josua* Stgr., ♂; and Fig. 6. *Lasiocampa josua* Stgr., ♀.

The following are illustrated in black and white (in the text), and where only the part is illustrated, it is mentioned in brackets below following the name :

Fig. 1. *Iolana alfierii* spec. nov. [Type] (♂ genitalia); Fig. 2. *Carcharodus stauderi ramses* Rev. (♂ genitalia); Fig. 3. *Carcharodus stauderi ambigua* Verity (♂ genitalia); Fig. 4. *Chondrostega subfasciata* Klug (fore-tibia); Fig. 5. *Chondrostega longespinata* Auriv. (fore-tibia); Fig. 6. *Anadiasa undata* Klug (larva); Fig. 7. *Anadiasa obsoleta* Klug (larva, after Klug); Fig. 8. *Pronotestra silenides* Stgr. (fore-leg); Figs. 9 and 10. *Pronotestra silenides* Stgr. (♂ genitalia); Figs. 11 and 12. *Anepia imitatoria* (Brandt) (♂ genitalia); Figs. 13 and 14. *Anepia imitatoria petroffi* sub-spec. nov. [Type] (♂ genitalia); Figs. 15 and 16. *Anepia silenides sancta* Stgr. (♂ genitalia); Fig. 17. *Pseudocopicucullia melanoglossa* (Berio); Fig. 18. *Pseudocopicucullia melanoglossa* (Berio) (♂ genitalia); Fig. 19. *Metlaouia oberthuri* Deck. (♂ genitalia); Fig. 20. *Eumichtis lea* Stgr. (♂ genitalia); Fig. 21. *Antitype juditha* Stgr. (♂ genitalia); Fig. 22. *Aporophila scriptura* Freyer (♂ genitalia); Fig. 23. *Aporophila cinesea* Stgr. (♂ genitalia); Fig. 24. *Bryomima sinaica* spec. nov. [Type] (♂ genitalia); Fig. 25. *Autophila rosea* Stgr. (♂ genitalia); Fig. 26. *Autophila dilucida* Hubner (♂ genitalia); Fig. 27. *Autophila cymaenotaenia orthotaenia* Wilts. (♂ genitalia); Fig. 28. *Autophila pauli* Boursin (♀ genitalia); Fig. 29. *Sidemias discordans* Boursin (♂ genitalia); Fig. 30. *Sidemias beduina* spec.

nov. [Type] (σ genitalia); Fig. 31. *Bryophila* (?) *paulina* Stgr. (σ genitalia); Fig. 32. *Hadjina viscosa* Freyer (φ genitalia); Fig. 33. *Hadjina viscosa* Freyer (σ genitalia); Fig. 34. *Propsalta coptica* spec. nov. (φ genitalia); Fig. 35. *Propsalta coptica* spec. nov. (σ genitalia); Fig. 36. *Hadjina palaestinensis* Stgr. (φ genitalia); Fig. 37. *Porphyrinia* (?) *virginalis* Ob. (σ genitalia); Fig. 38. *Porphyrinia* spec. (σ genitalia); Fig. 39. *Porphyrinia* spec. (σ genitalia); Fig. 40. *Xanthoptera mesozona* Hamps. (forewing); Fig. 41. *Xanthoptera mesozona* Hamps. (σ genitalia); Fig. 42. *Thalerastria diaphora* Stgr. (σ genitalia); Fig. 43. *Thalerastria diaphora* Stgr. (forewing); Fig. 44. *Thalerastria alfieri* spec. nov. [Type] (σ genitalia); Fig. 45. *Thalerastria alfieri* spec. nov. [Type] (hindwing neuration); Fig. 46. *Thalerastria rex* spec. nov. [Type] (σ genitalia); Fig. 47. *Thalerastria rex* spec. nov. [Type] (hindwing neuration); Fig. 48. *Eulocastra schah* Salz and Brandt (forewing); Figs. 49 and 50. *Eulocastra schah* Salz and Brandt (σ genitalia); Fig. 51. *Eulocastra tamsina* Brandt (σ genitalia); Fig. 52. *Thalerastria rex* spec. nov. [Type] (forewing); Fig. 53. *Eulocastra tamsina* Brandt (forewing); Fig. 54. *Thalerastria alfieri* spec. nov. [Type] (forewing); Fig. 55. *Ophiusa albivitta* Moore (σ genitalia); Fig. 56. *Ophiusa albivitta* Moore (φ genitalia); Fig. 57. *Ophiusa algira* L. (φ genitalia); Fig. 58. *Clytie sancta* Stgr. (σ genitalia); Fig. 59. *Leucanitis picta radapieta* Stgr. (σ genitalia); and Fig. 60. *Syneda habibazel* Dumont (σ genitalia).

Further text-figures appear in the Addendum.

REFERENCES

For a fuller Egyptian and African bibliography, see Hayward 1925. The following are the main literary references made in this Part; others are given in full in the text. Some of the works referred to are not explicitly on the Egyptian Fauna as such.

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GLOSSARY AND EXPLANATION OF ABBREVIATIONS

The months are indicated by small Roman figures, e.g. i=January, ii=February, etc. Other abbreviations have been avoided except the three given below :

A.A.=taken by, observed by, or in collection of, Anastase Alfieri.

P.=taken by, or in collection of, Petroff.

E.P.W.=taken by, observed by, or in collection of, E. P. Wiltshire.

The following zoogeographical and phenological terms are used in the senses given :

Anatolian-Iranian=with their centre of distribution in Anatolia and Persia. This category is one of several « east Mediterranean » categories which in their turn are components of the Old World Warm-Temperate geofaunas.

Autumnal=flying in autumn.

Bivoltine=with two broods per annum, and no more, even in a warm climate.

East Mediterranean=(1. *sensu stricto*) inhabiting the shores and islands of the Eastern Mediterranean (*cf.* Anatolian-Iranian) ; (2. *sensu lato*) inhabiting the same but also the Balkans, Anatolia, Iran, and parts of Central Asia.

Eremic=inhabiting deserts and steppes, and oases therein, and in particular those North of the Equator in the Old World (see also Pan-Eremic, below).

Euro-oriental=inhabiting parts of Europe and Asia but absent from Siberia and the Pacific coasts ; on the whole, a Warm-temperate category, with its centre in South-West Palearctis, but some species range from Britain to Tibet or West China.

Euro-Siberian=inhabiting parts of Europe and Asia, from the Atlantic to the Pacific (=Euro-Pacific, Zerkowicz). On the whole a cool-Temperate category.

Holarctic=inhabiting the North-Temperate Zones of the Old and New Worlds.

Holo-Tropical=inhabiting chiefly the Tropical zones of the Old and New Worlds.

Mediterranean=(1. *sensu stricto*) inhabiting the shores and islands of the whole Mediterranean basin, including parts of the Black Sea Coast; frequently however absent from Egypt owing to its low rainfall and lack of scrub woods. (2. *sensu lato*) a group of categories including the Mediterranean, Anatolian-Iranian and even Euroriental. A generally Warm-temperate category. Semenov-Tian-Shanskij (Moscow, 1936) has even included the Eremic, but it seems better not to use the term Mediterranean in so wide a sense despite the Mediterranean rainfall-regime of the Northern Sahara.

Multivoltine=performing at least three life-cycles annually in warm climates; the broods may overlap or be distinct.

Palaearctic=inhabiting the Old World mainly North of the Tropic of Cancer.

Paleo-Tropical=inhabiting principally the Tropical zone of the Old World, i.e. both India and Africa.

Pan-Eremic=the widest latitudinal Eremic range, from the Atlantic Ocean to Central Asia (see Eremic, above).

Univoltine=only completing one life-cycle annually even in warm climates.

Vernal=flying in spring or early summer.

SYSTEMATIC LIST

A modern list should begin with the most primitive and end with the most advanced group or species. Since however my studies of the more primitive (the smallest) are not yet ready for publication, I am arranging this list in the reverse order; it is not yet sure that I shall be given the opportunity to study all, owing to the time this takes.

I follow here, with one or two minor changes, the classification of Carl Borner (1939, 1944) and Hinton (1946), for the terminology and phylogenetic order of the broader groups. For the classification followed within each of these broad groups, see my remarks under each Super-Family or Family, below.

Order : LEPIDOPTERA

Sub-Order : DITRYZIA

Super-Family : P A P I L I O N O I D E A

I follow B. C. S. Warren (1947) for the order of families hereunder.

Family : SATYRIDAE

1. *Eumenis pisidice* Klug.

Two specimens (A.A.), 1.viii.10, near St. Catherine's (South Sinai), and 24.v.35, Wadi el Ghedeirat (North Sinai).

Confined, in Egypt, to Sinai; also inhabiting middle heights in Palestine and Lebanon. A close relative inhabits South-West Arabia (Asir Mounts). Presumably it resembles its congeners in feeding on grass. The two records above, and the other known captures, show the species to be continuously-brooded during the summer months.

Family : DANAIDAE

2. *Danaïs dorippus* Klug.

One (A.A.), 23.iii.-end iv.28, Gebel Elba.

A Tropical species, confined to the mountains of Tropical Egypt (i.e. South-East Egypt) with monsoon rains.

3. *Danaïs chrysippus* L.

All the year round, on oasis ground, from North to South Egypt. Williams (1929) studied its seasonal abundance at Giza near Cairo with that of three other common butterflies. He found from records kept for four years that its greatest abundance was in autumn or winter but that it was practically never absent on the wing. It was usually somewhat commoner in vi and vii than in late spring and early autumn. A marked increase in xi.26 he thought due to immigration. Hayward (1925) found that at Aswan it flew commonly all the year round in successive broods. He also gives a very full account of the various forms of the butterfly and the times of the year at which they tend to appear at Aswan; also of the biology.

Foodplant : *Asclepiadaceae*.

In Egypt it is not only found throughout the Nile valley and delta but also in the Fayoum and the Oasis of Bahariya. Elsewhere, it is very widespread in the Old World Tropics.

Family : NYMPHALIDAE

4. *Charaxes hansali* Feld.

One large ♀, 23.iii.-end.iv.28 (A.A.), Gebel Elba.

A Tropical East African species.

5. *Junonia lintingensis cebrene* Trim.

One, 23.iii.-end iv.28, Gebel Elba (A.A.). This collection however also contains notes to the following effect :

(a) At Salsileh, near Kom Ombo, Upper Egypt, A. Honoré observed an important migration between 14 and 28.viii.38, and captured three examples.

(b) Seen, an example in coll. Ministry Agriculture, taken by Prof. H. Priesner at Nag-Hamadi on 27.iv.38.

It appears therefore that this widespread Tropical butterfly is confined to Upper Egypt but is less local than Nos. 2 and 4 above.

6. *Hypolimnas misippus* L.

2 ♂♂, 17.v.21, Gizeh, and vi. Marg (i.e. both from the Cairo vicinity) (A.A. ex coll. Dr. Innes Bey). 1 ♀, 12.vii.22, Kerdacé (A.A.). Also « rare at Aswan » (K.J. Hayward).

Widespread in the Tropics of the Old and New World, but a comparatively rare immigrant in Egypt.

7. *Vanessa cardui* L.

Throughout Egypt, but of uneven appearance. At Aswan, Hayward (1925) found it to fly all the year round. Around Cairo it is commoner in the cooler months; in his study of four butterflies, Williams (1929) reported it as « usually not common » at Giza; very rare during the hotter months, not uncommon in autumn and winter, liable to be reinforced by immigrants in spring. The material before me and my own notes also show it to be taken in the desert principally in spring. It has been noted in Sinai (Rebel, 1909).

Foodplants: *Malva parviflora*, *Cynara*, thistles.

A migrant widespread in the Tropics and Sub-Tropics of the Old World and also in the Sub-Tropics of North America.

8. *Vanessa atalanta* L.

19.viii.33, Gebel Asfar; 12.i.18, Gezireh, Cairo; 10.i.19, Alexandria; 25.xi.26, Hawamdieh (near Cairo); (A.A.). Two in February from Alexandria (P.).

The first of these dates is very surprising, for this migrant has a more northerly headquarters than No. 7, and usually disappears entirely from dry and torrid subtropical districts for the summer. It is not known to breed in them on its winter visits.

Its range is Holarctic.

9. *Melitaea deserticola* f. *trans.* ad *subspec. macromaculata* Belt.

Seitz' remarks on this genus, in Andres-Seitz (1923) should be ignored, being based on the early, too superficial, view of this difficult genus. See Higgins (1941) for the specific rank of *deserticola* Ob. and other forms confused with *didyma* O. As for the question of the name of the Egyptian race, the rich material detailed below has led me to determine the race as transitional between the Eastern and the Western.

3 ♂♂, 12.iv.40, 390-1700 m., Wadi Isla; 1 ♂, 22.iv.40, Wadi el Ra-

baa; 1 ♀, middle iv.40, Wadi el Rabaa, Gebel Katherina; all S. Sinai; 1 ♂, v.1920, Wadi Karam, N. Sinai (A.A.).

1 ♂, 21.iii.22, Ougret el Sheikh; 5 ♂♂, 7.vi.21, Ougret el Sheikh; 1 ♀, 1.iii.22, Waadi Rishrash; all Eastern Desert (A.A.); 4 ♂♂, 4 ♀♀, iv and v, Wadis of Gebel Mokattam, etc., Eastern Desert (P.).

The difference between spring and summer broods is not marked; the two spring specimens from Ougret are blacker-bodied than the more numerous summer specimens from the same locality. The Sinai April specimens tend to resemble the Ougret spring brood.

The form *harterti* Roths., thought to be seasonal, occurs both in the spring Sinai and the Ougret summer series, but not in the majority even of the latter.

Some of both series also correspond to form *macromaculata* Belt, as described in Higgins (1941); the black lunules, forming the proximal border of each orange macule in typical *deserticola* Ob. hind-wing, under-side, are lightly defined in the spring series from Ougret and the April Sinai specimens, but absent from all the others.

In Egypt this butterfly seems to be confined to rather inaccessible parts of the desert valleys to the South-East of Cairo and to the similar valleys of Sinai, where however it ascends to quite a height.

Foodplant: *Linaria aegyptiaca* (see Graves, this Bulletin, 1915).

An Eremic species, inhabiting the Sahara from Morocco eastwards to Egypt, and also Transjordan, the Lebanon and probably North-West Arabia; but the *Melitaea* inhabiting South-West Arabia south of the Tropic is a different species.

10. *Melitaea trivia robertsi* Butl.

1 ♂, 27.iv.18, Ain Sina (Sinai); (A.A.).

Foodplant: not observed here but doubtless either *Verbascum* or *Scrophularia*. Probably tri-voltine, as in Lebanon and Palestine.

A Euroriental species, known in Egypt only from Sinai.

Family: LYCAENIDAE

In the following arrangement of this family I am indebted to Monsieur H. Stempffer who has the widest knowledge of these butterflies. Forster's arrangement (1938) was unsuitable owing to its omission of Tropical genera found in Egypt: indeed, the study of these omitted genera will probably necessitate further changes in it. The erection of the sub-family *Aphnaeinae* is M. Stempffer's, but he has not published it yet; for full details readers must await his promised revision of African *Lycaenidae*. Mr. F. Hemming, C.M.G., has also helped me in this family, and Dr. W. Forster's co-operation must be gratefully acknowledged.

Sub-Family : Theclinae**11. Deudorix livia Klug.**

Multivoltine, all the year round. Common in oases of Lower Egypt, also at Aswan (K.J.H. Hayward).

Food plants : Pomegranate, and *Acacia farnesiana* (Futna).

The distribution of this species is North-East African — South-West Asian, cutting across the desert zone from South to North in this area. It is strongest on the coasts of the Red Sea and the East Mediterranean, and in the Nile valley.

12. Tomares ballus mareoticus Graves.

Only in i, ii, and iii, in the Mariout district.

Univoltine, vernal. Mediterranean.

13. Anthene amarab Guerin.

Four, 15.iii to end iv.28, Gebel Elba; one, end x.24, Wadi Gemal. The species is thus confined in Egypt to the extreme South-East like No. 2. A widespread African butterfly, also inhabiting South-West Arabia.

Sub-Family : Aphnaeinae**14. Apharitis acamas egyptiaca Riley.**

9 specimens, in iii, vii, viii and x, all from the Suez Road, between 5th and 7th towers (i.e. between Suez and Cairo, Eastern Desert) (A.A.). The species is also reported from Sinai (Rebel, 1909).

Multivoltine. Pan-Eremic.

15. Apharitis myrmecophila Dumont.

One, 13.vi.25, and two 2.ix.25, Geneifa, Canal Zone (A.A.).

Multivoltine. Eremic, ranging from Tunis to Arabia.

Sub-Family : Lycaeninae**16. Lycaena phloeas L.**

One, 20.viii.45, Urman Gardens, Giza, Cairo (leg. Price); two, 24.v.35, Wadi el Ghedeirat. North Sinai; one, 26.iv.18, Ain Sina; one, 26.viii, Abu Hameida; both Sinai; all A.A.

Multivoltine.

Its occurrence in Cairo implies that it should occur also rarely in the Delta; it is evidently commoner in Sinai: the form *caeruleobasalis* was described from Solloum in this journal 1930. It is an oasis rather than a desert butterfly, but becomes euryoecous with increasing rainfall. It occurs outside the Palearctic region only in South-West Arabia and East Africa at great heights.

Euro-Siberian.

17. *Lycaena thersamon* Esp.

One ♀, 8.5.32, Wadi Um Mittla (Sinai).

Multivoltine. Euroriental.

Sub-Family : L a m p i d i n a e

18. *Cosmolyce baeticus* L.

All the year round in Upper-Egypt; in all months except xii and i in Lower Egypt. Known also from Sinai, and from the deserts of South-East Egypt.

Foodplants : *Papilionaceae*

Elsewhere, a widespread and migratory Tropical species.

19. *Syntarucus telicanus* Lang.

All the year round; widespread in Egypt, especially common in oases but also taken in the desert. Elsewhere, widespread in the Old World Tropics and Mediterranean basin. Polyphagous.

20. *Tarucus mediterraneae* B.-Baker.

Recorded as *theophrastus* F. by Andres-Seitz. I have examined the genitalia of *Tarucus* species from all over Egypt but not found a single true *theophrastus*. In his article, describing *mediterraneae*, Bethune-Baker nowhere states that *theophrastus* occurs in Egypt. Of the four (*) North African species, therefore, in this group, *mediterraneae* is the only certainly Egyptian species at present.

Multivoltine, occurring in iv, vi, vii and viii near Alexandria (P.); Gezira, Cairo, 12.vi.47 (E.P.W.); one ♂, 15.x.47, Luxor (leg. Unwin); one ♂, 22.iii.35, Bahariya Oasis (A.A.); 25.viii.22, Maadi, near Cairo (A.A.), etc..

Foodplant : *Zizyphus spina-christi*.

Distribution : Eremic.

Sub-Family : E v e r i n a e.

21. *Azanus ubaldus* Gr.

One ♂, Ezbet el Bous, road to Khargeh Oasis, Libyan desert, 20.x.27; one ♂, 24.x.16, Helwan; one ♀, 4.xi.19, Maadi, near Cairo; one ♀, 2.xi.16, Cairo; (all A.A.). At Aswan, according to Hayward, it occurs in summer and autumn, being commonest in and after viii, and « easily killed off by cold ».

Foodplant : *Acacia* (? *nilotica*).

(*) These four are *T. balkanicus* Freyer, *theophrastus* F., *mediterraneae* B.-B., and *unquemachi* Stempffer. For the genitalia of all four, see Stempffer (1942): *Ann. Soc. Ent. France*, CXI, 117, ff..

An African species, evidently not much at home north of the Tropic of Cancer, and doubtless commonest in Upper Egypt.

22. *Azanus jesous* Guér.

One ♂, 24.v.35, Wadi el Gheideirat, North Sinai (A.A., leg. Rabinovitch). Larger than No. 21.

It has a similar range and biology to No. 21, but penetrates further north in the East Mediterranean (i.e. coast of Lebanon).

Sub-Family : *Plebeinae* (= *Polyommata* Forster)

23. *Chilades eleusis* Dem.

Two from Aswan, 1.xi.19 (A.A.).

Multivoltine, from iii to xi, according to Hayward. Has not been noticed in Lower Egypt since Staudinger described a specimen from Cairo (xii) as *pharaonis*, said to be a synonym.

Known also from the Sudan, Abyssinia and Nigeria. Its two close relatives are Eremic, but occur as follows : (a) *galba* Led. in Cyprus, Syria, Palestine, Iraq, and Oman ; (b) *phiala* Gr.-Gr., Turkestan. The rest of the genus are Tropical.

24. *Fryeria trochylus* Courv.

Inhabits the Mariout, the Delta, the vicinity of Cairo and Helwan, and the Nile valley southwards to Aswan.

Foodplant : heliotrope (sec. Andres). I have however seen it flying in numbers over *Alhagi* at Helwan, and think this may also be a food-plant.

Multivoltine.

A Tropical and East Mediterranean species.

25. *Polyommatus pylaon philbyi* Graves.

3 ♂♂, 1 ♀, 18-27.iv.40, Wadi el Rabaa (Gebel Katherine), 1500 m., South Sinai (A.A.). A-Eurooriental species, inhabiting steppes and mountains, but seldom, if ever, true deserts.

Rebel (1909) recorded, as taken by Kneucker in Sinai, "*Lycaena argus bella*" and "*Lycaena sephyrus zephyrinus* Chr.". The specimens are not available for a critical examination, but *argus* must be deleted from the Egyptian list; *sephyrus* however is the Balkan race of *pylaon*, so probably the second of Rebel's species is No. 25, correctly designated above. Perhaps furthermore Rebel's Sinai "*argus*" is the same; at any rate, *philbyi* might be taken for an *argus* form (and has been!) unless the genitalia are examined, and some examples have the upperside hindwing orange spots in the male which apparently occur in *bella*. The nearest species to Sinai of the *argus* group is *P. argyrognomon* Bergst. which inhabits the mountains of the Lebanon. Its occurrence in Sinai seems to me rather unlikely.

26. *Polyommatus loewii* Z.

Flies in iv and v in the Eastern desert and Sinai. There is no need to recapitulate the various attractive varieties here.

Foodplant : *Astragalus forskalii* (sec. Andres).

Pan-Eremit.

27. *Polyommatus icarus* Rott.

Four. ♂♂ and ♀♀. 24 and 25.v.35. Wadi el Ghadeirat Sinai, (A.A., leg. Rabinovitch).

In Egypt, like No. 25, confined to Sinai, but elsewhere of a wider range.

Euro-Siberian.

Sub-Family : Glaucopsychinae

28. *Philotes abenterragus coloniarum* Tur.

Flies in the Marout in iii, v and apparently also in vi (Petroff's catalogue II.). Specifically distinct from *baton* Berg. of which Andres-Seitz (1923) treated it as a form.

This race was found from Cyrenaica. Perhaps the Transjordan race *radiatus* Graves will be found in Sinai. A Mediterranean species, occurring here on steppe desert.

29. *Iolana alfieri* spec. nov. (Plate I, figs. 1 and 2).

Nearest to *Iolana gigantea* Gr.-Gr., 1885 (*Lyczena gigantea* Gr.-Gr., 1885.).

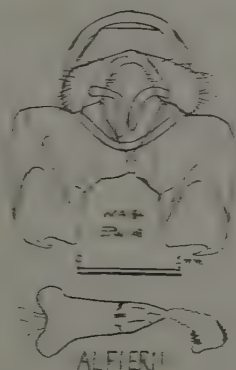


Fig. 1 : *Iolana alfieri* spec. nov.: dorsal posterior view of ♂ genitalia, with aedeagus separated.

♂ : Eye, hairy. Forewing, rounded and full, metallic pale sky-blue, with an underlying base of mauve; without cell-spot, but with dark brown termen and nervures finely dark brown distally; on hindwing, r. and m.

nervures are brown throughout whole length. Fringes white. Underside, brown-grey, with long narrow white-edged ocell-cross-bar on both wings and a complete series of white-edged black discal spots. In the forewing these number seven and run almost in a straight line parallel to the margin; in the hindwing, the second spot is in line with the first three, thus distinguishing the species from the Central Asian *I. gigantea* Gr.-Gr., in which the second spot is out of line. Two other similar spots near the base of hindwing. Marginal ocelli, represented by faint grey circumflex-marks on forewing, and by double similar marks on hindwing, except at anal angle, where there is (a) a pair of black spots, and (b) a single black spot; a small whitish cloud separates these spots from a proximal grey mark. The hindwing is slightly grey-blue-suffused basally. Fringes, white. There are only eight black spots on the forewing underside, as mentioned above.

Span : 35 mm. (32 from apex to apex).

The male genitalia (see fig. 1) show this species to be rather closer to *gigantea* Gr.-Gr. than to *iolas* O.

Holo-Type ♂ and one Para-Type ♂; 13-27.iv.40, Wadi el Rabaa (Gebel Katherine), 1500 m., South Sinai, flying in sun-light in the lee of small cliff (Leg. A.A.). In coll. Alfieri.

Sub-Family : Zizeerinae

30. *Zizeeria knysna karsandra* Moore.

The race of Upper Egypt is that widespread to the North of the Palearctic desert belt, i.e. from Algeria eastwards to Syria and Northern India; apparently the same form occurs as far south as Aswan, though I have not examined the genitalia of Aswan specimens. Perhaps in the extreme South-East, i.e. at Gebel Elba, the South African form, *knysna*, may be found, for it occurs in South-West Arabia and the Sudan, and, according to Mr. A.S. Corbet, in litteris, northwards up the West Coast of Africa to Spain and Portugal.

Chiefly on oasis territory.

Foodplants : *Trifolium alexandrinum*, etc.. Multivoltine, throughout the summer and autumn.

Family : PIERIDAE

31. *Pieris rapae* L.

Inhabits oasis ground southwards through the delta and Nile valley to Aswan. Occasionally, too, on desert ground : one, 21.iii.48, Wadi Hof (E.P.W.). Williams (1929) found it most abundant in Giza in early summer; during vii, viii and ix of three years it was almost absent, but reappeared again in small numbers from xi to iv, when it increased rapidly;

in the fourth year however it was quite common in viii and ix, and then, after a short break, became even commoner in late x and xi. There are specimens from North Sinai at Kosseima and it may inhabit the remoter oases too.

Foodplants of this multivoltine, Holarctic, somewhat migratory pest are *Cruciferae* and *Resedaceae*.

32. *Pieris brassicae* L.

One, 17.vi.12, Amrieh, Mariout (A.A.)

Evidently extremely rare in Egypt, probably only a migrant from Cretenaica.

Foodplants : *Brassica*; in Cyprus : *Capparis spinosa*.

A migratory pest; Euroriental.

33. *Leucochloe glauconome* Ob.

Known from the Eastern Desert and Sinai.

Multivoltine, on the wing in most months, and may be found in an early stage even in the coldest.

Foodplant : *Zilla*.

A true desert butterfly, Pan-Eremic in range.

34. *Leucochloe daplidice* L.

Occurs throughout Egypt and Sinai, but is rather irregular and migratory.

Multivoltine, but not usually seen in viii and ix.

Foodplants : *Cruciferae* and *Resedaceae*.

An Euroriental or Mediterranean butterfly, ranging across the Tropic in South-West Arabia and into the high mountains of East Africa. Seitz' remarks (1925) that this species is a vicariant of No. 33 and that they seldom occur together is not applicable to Egypt, nor to most of the range of these two butterflies, if indeed, to any part thereof at all. It occurs in the desert together with *glauconome* but also inhabits oases.

35. *Glycestha aurota* F. (= *mesentina* Auctorum).

Rare and sporadic in Egypt and Sinai. The only new material before me, beyond the records in previous lists, are a series in colls. A.A. and P. taken on 18.v.18 by Storey at Rashida (Dakhla Oasis).

Multivoltine, migratory.

Foodplant : *Capparis*.

Its range is in the dry Tropics and Sub-Tropics of the Old World, but its centre is certainly Tropical.

36. *Euchloe crameri aegyptiaca* Verity.

Inhabits the Eastern Desert and the Mariout; also Damanhour (in

the Nile Delta, and probably Sinai, for the same race has been taken at Petra in Transjordan.

Vernal, bivoltine, ii-v. Euroriental.

37. *Euchloe belemia* Esp.

Flies in the Cairo vicinity in I and II. Has also been recorded from the Fayoum, the whole delta, and the Mariout.

Rebel's unconfirmed record 1909 at E. Jeddou Allard from Sinai is perhaps an error for this species.

Vernal, bivoltine, the earliest brood often appearing in November.

Foodplant: *Cruciferae*.

A mediterranean species inhabiting oases and steppe terrain from Morocco to South Persia.

38. *Anthocharis charlonia* Donz.

Only known from the Mariout, from xii to iv. Probably also Sinai.

Bivoltine, vernal, the first brood sometimes, like No. 37, appearing before the New Year, especially in mild climates.

A Pan-Eremic butterfly inhabiting deserts steppes and also high mountains.

39. *Colotis phisadia palaestinensis* Stgr.

Two, 20.vii.35, Hurgada (A.A.). Also Sinai (Rebel, 1909).

Probably commoner further south along the Red Sea coast.

Foodplant: *Salvadora persica*; the butterfly is usually taken swarming over this plant.

Multivoltine.

A Tropical-Eremic butterfly ranging from Morocco to Mombasa, Abyssinia and Sind.

40. *Colotis chrysonome* Klug.

Two (♂, ♀), 15.iii-end iv.28, Gebel Elba (A.A.).

An Eremic species, also penetrating southwards to Tanganyika, eastwards to Transjordan and Arabia and westwards deep into the Sahara.

41. *Colotis danae eupompe* Klug.

One ♂, 15.iii-end.iv.28, Gebel Elba (A.A.).

Ranges from India to South Africa and Senegal, i.e. a Tropical species.

42. *Colotis evenina casta* Gerst. (= *castina* Le Cerf).

One ♂, 15.iii-end iv.28, Gebel Elba (A.A.). This is the northernmost record for this Tropical species, which ranges into South Africa.

43. *Colotis fausta* Oliv.

A long series from the Eastern Desert and Sinai spread from iii to x (A.A.).

Associated with *Capparis spinosa*.

A Tropical-Subtropical Eremic species ranging from Ceylon to Egypt but no further westwards. It is thought to be a migrant but can hardly be so in Egypt to an appreciable degree otherwise it would have been met with west of the Nile valley. In the Sub-Tropics it seems to die out every winter.

44. *Colias croceus* Fourc.

Collections A.A. and P. contain specimens taken in ii-vii and in x, from the Mariout, the Suez Road, Cairo district, Tourah (South-East of Cairo), and the Dakhla Oasis.

This agrees with the results of Williams' (1929) study of four butterflies at Giza; its increase starts later than that of *Pieris rapae* (No. 31), the maximum being in late vi; by late vii it has almost completely disappeared. In 1926 there were a few isolated autumn and winter records.

Hayward however found it common all the year round at Aswan, though not in equal numbers in every month. It also inhabits Sinai (Rebel, 1909).

Multivoltine.

Foodplants: *Medicago sativa* (Lucerne), and other Papilionaceae.

A Euroriental migratory butterfly also penetrating the high tropical mountains of South-West Arabia and East Africa.

45. *Catopsilia florella* F.

Not uncommon in the Cairo district, and the Eastern Desert. Specimens bred from larvae on *Cassia obovata* hatched in v and ix (A.A.). Others were taken on the wing in ii and iii. At Aswan Haward observed it all the year round.

A Tropical migrant inhabiting chiefly Africa and South-West Arabia.

Family : PAPILIONIDAE

46. *Papilio machaon saharae* Ob.

Five from Sollum (some bred from a unidentified foodplant), and one from 7th Tower, Suez road on 26.iv.25; this example is marked « Two others seen »; (A.A.). This seems to be the eastern limit of the small North African desert race. It is evidently scarce in Egypt.

The Egyptian foodplant is probably the same as that observed in Cyrenaica, viz. the desert umbellifer *Pityranthus tortuosus*. The limiting factor for the butterfly in Egypt is obscure, since foodplant un-availability is clearly not the reason for its scarcity and localness. Multivoltine.

A Holarctic species, concentrated in the Palearctic Region, crossing the Tropic only in South-West Arabia at 10,000 ft.

Super-Family : **HESPERIOIDEA**

This super-family has sometimes been regarded as a Sub-Order (*Grypocera*) but according to modern notions the groups : *Rhopalocera*, *Heterocera*, etc., do not deserve sub-ordinal rank.

I am indebted to Brigadier Evans for assistance in this super-family, but while I retain his order and grouping, it should be noted that he prefers not to use any names for sub-orders and super-families, but uses the family name *Hesperidae* for the above super-family. For the sake of consistency I have elevated hereunder to family-rank groups which he places at sub-family rank (e.g. *Pyrginae*, *Hesperiinae*).

Family : **PYRGIDAE**47. *Sarangesa phidyle* Walker (= *eliminata deserticola* Rebel).

Four, 15.iii-end iv.28, Gebel Elba (A.A.).

This Tropical species only enters Egypt in the extreme south-east, and like Nos. 2, etc., hardly belongs to the fauna of Egypt proper.

48. *Gomalia elma albofasciata* Moore.

Four, to which the same data and remarks as for the foregoing (No. 47) apply also.

49. *Carcharodus stauderi* Rev.

Two structurally distinct subspecies of this butterfly inhabit Egypt, ssp. *ramses* Rev. in the Mariout and ssp. *ambigua* Verity (which is also wide-

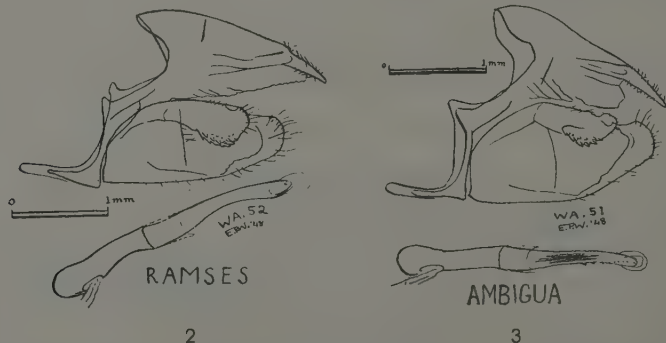


Fig. 2 : *Charcharodus stauderi ramses* Rev. : lateral view of ♂ genitalia, with right valve detached and aedeagus separated. — Fig. 3 : *Charcharodus stauderi ambigua* Verity : lateral view of ♂ genitalia, with right valve detached and aedeagus separated.

spread in South-West Asia) in Sinai. For the structural differences see figs. 2 and 3 : in particular *ramses* (fig. 2) lacks the spiral series of aedeagus-spines described as typical of *stauderi* by Reverdin (*Bull. Soc. Lép. Genève*, II,

234). In colour the first broods differ considerably, but *ramses* appears to have but one brood, whereas *ambigua* has at least three, and the later generations greatly resemble *ramses* in their paler « drier » colouring.

Ramses : iv and v, Mariout (A.A. and P.). The foodplant was noted as *Phlomis floccosa* at Mersa Matruh.

Ambigua : two males, 10.iv.40, Wadi Isla, Karm Alam, 650 m. (South Sinai), and 18.iv.40, Wadi el Rabaa, 1400 m. (Gebel Katherine, S. Sinai), (A.A.).

An Eremic species occurring from Morocco to Persia.

50. *Carcharodus alceae* Esp.

Not previously recorded from Egypt; a single male from Wadi Talaa, Gebel Katherine, 19.iv.40 (A.A.) shows that it inhabits the high mountains of South Sinai. The form is *claraustralis* Verity which Evans considers a mere synonym of *alceae*; this is the Palestinian form.

So far only one brood has been taken, but doubtless there are two or three more.

Foodplant : *Althea* (hollyhock).

A Euroriental species.

51. *Spialia doris amenophis* Rev.

In the Eastern Desert in iii, iv, v and vi and again more rarely in ix; also on Gebel Elba between 15.iii and end iv.

Foodplant : *Convolvulus lanatus* (according to Andres).

Full details of the biology are given in Andres-Seitz, 1923.

An Eremic species occurring both sides of the Tropic of Cancer in Asia and Africa.

Family : HESPERIIDAE

52. *Pelopidas thrax* Led.

This species has been previously confused with the very similar species *mathias* F.. It was not noted at Aswan by Hayward; it is common on oasis ground near Cairo and in the Delta; there is also one specimen taken in the desert (27.x.16, Wadi Hof (A.A.)).

Foodplants : sugar-cane, rice and grass, sometimes being noted as destructive.

Multivoltine, from iii to xi, but not continuously in any one locality. The broods are usually fairly separate, I have found.

A Tropical and Sub-Tropical African and West Asian species.

53. *Pelopidas borbonica zelleri* Led.

The Cairo specimens are blacker than the Delta and Alexandria forms which are brown. The male lacks the linear stigma on the forewing present in *thrax* (No. 52). It was not noted at Aswan by Hayward.

Foodplants : grasses and rice. All the year round, but commonest in summer.

A Tropical and Sub-Tropical African species, inhabiting West Asia also.

54. *Gegenes nostradamus* F.

Distinguished from the two foregoing species by the absence of white spots on the male forewing. From *Gegenes pumilio* Hoffm. (= *lefebvrii* Ramb.) it is distinguished by its brown, not black ground colour. *G. pumilio* has not been certainly taken in Egypt, but might occur here.

This species is distributed from North to South of Egypt, and is common on oasis biotopes, i.e. especially the Nile valley. It flies from ii to xi, being multivoltine.

Foodplants : Gramineae.

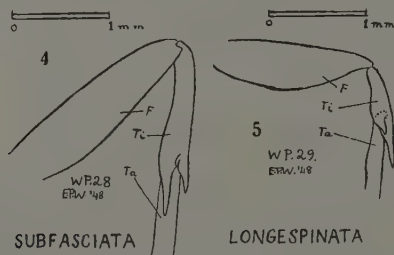
A Euroriental species which occurs south of the Tropic of Cancer in South-West Arabia.

Super-Family : BOMBYCOIDEA

Family : LASIOCAMPIDAE

55. *Chondrostega subfasciata* Klug.

Of the two species of this genus, known certainly from Egypt, *subfasciata* Klug can be distinguished, according to Aurivillius, who exa-



Figs. 4 and 5 : *Chondrostega* fore-leg (F, femur; Ti, tibia; Ta, tarsus) : (4) *subfasciata* Klug, (5) *longespinata* Aur.

mined the types, by its shorter tibial spine and clearer markings. Seitz (Vol. II), though omitting to mention the spine, is to the same effect. It is therefore very puzzling to find that Andres-Seitz (1923) say that *longespinata* Auriv. is the better-marked. One must conclude either that Andres had his two species the wrong way round or that there is some third species in Egypt which he mistook for one or the other.

A long series from the Mariout, in ix and x (P.). These agree perfectly with Klug's plate; they are intermediate in aspect between *zanoni* Turati

and *aurivillii* Pung., which may well be the Cyrenaican and Palestinian races respectively of Klug's species. The tibial spines of this and the next species are illustrated (figs. 4 and 5).

56. *Chondrostega longespinata* Auriv.

This species flies in the Mariout in x and xi (P., A.A.) and apparently also in the Eastern Desert, since of two identical larval skins one is marked « 25.xi.25, Bir Gandali (i.e. 25 miles South-East of Cairo), very abundant on khubbaysa (i.e. *Malva parviflora*), désert arabique », (A.A.), and the other is from the Mariout. These skins differ from the descriptions of two species of *Chondrostega* larvae described in Andres-Seitz. The ground-colour is black, but there are conspicuous cream-coloured transverse dorsal bars in the somital joints. The hairs are yellowish brown, crimson sublaterally on somites 1, 2 and 3, and crimson dorsally on 4, 5 and 6. The lateral warts above the spiracles are conspicuous and pale brown; the sub-lateral warts below the spiracles are similarly coloured but less conspicuous; the dorsal warts being black are un conspicuous; so are the spiracles. I am however not perfectly satisfied that these skins are conspecific with the adults examined, but whatever the species, it inhabits both the Eastern desert and the Alexandria district.

This and other species of *Chondrostega* are univoltine autumnal desert or steppe moths with wingless females; the long pupal diapause (aestivation) is spent in a subterranean cocoon.

An Eremic species probably also occurring outside Egypt.

57. *Lasiocampa serrula aegyptiaca* Ob. (Plate VII, figs. 1 and 2).

It should first be mentioned that the form *aegyptiaca* Ob. comes very close to *palaestinensis* Stgr., and possibly should not be separated; both occur in Egypt, and on the whole the Egyptian form has, in the male hindwing, a less pronounced pale fascia than *palaestinensis* (Plate VII, fig. 3). On the other hand the species is most variable and in its most bleached, « dry » forms approximates to form *dauidis* Stgr. (Plate VII, fig. 4), originally described as a distinct species. Both *aegyptiaca* and *dauidis* have been bred from the same larvae from the same locality (Suez Road). The material is as follows:

(a) wet form (lilac grey forewing, brown hindwing), *aegyptiaca*: three (2♂♂, and 1 ♀), viii, ix, 1913, Alexandria (A.A.); five (1♂, and 4♀♀), hatched late x.21, from larvae, Suez Road, feeding on *Haloxylon schweinfurthi* (det. Debsky), (A.A.); three (1 ♂, and 2 ♀♀), 5-15.x.18, hatched from larvae, Mariout (P.).

(b) dry form (bleached creamy white forewing and hindwing), *dauidis*:

seven (5 ♂♂, and 2 ♀♀), hatched from larvae, Suez Road (Eastern Desert) in mid and late x (A.A.).

Three larval skins from this last locality are preserved, and when compared with the good coloured Plate I in *Nov. Zool.*, XXV (1918) and the text of Rothschild in *id.*, XXIV (1917), they agree, but resemble the form of larva of *serrula* f. *undulata* in Algeria rather than *serrula palaestinensis*, i.e. the segmental interspaces are in all three skins black, not blue.

An Eremic species of North Africa and Palestine.

58. *Lasiocampa josua* Stgr. (Plate VII, figs 5 and 6).

Two (1 ♂, and 1 ♀), 31.x.17 and 22.x.17, Mariout, leg. Storey.

This species has not been previously recorded from Egypt, but is known from Palestine and Algeria; the examples were apparently wrongly classified under *serrula*. The male is less yellow-speckled than typical Palestinian *josua* but without a longer series it would not be safe to regard it as a distinct race; its discal spot moreover is elongated but this is doubtless aberrational.

An Eremic species of North Africa and Palestine.

59. *Lasiocampa grandis* Rog.

One ♀, 18.viii.22, Deirout, Beheira, leg. Basiliadis (A.A.). Also recorded from the Eastern delta in Andres-Seitz (1925).

Larva, polyphagous. Univoltine, autumnal.

An East-Mediterranean species, of which the Nile is evidently the western limit; commonest in Lebanon, ranging to S.W. Persia.

60. *Lambessa decolorata* Klug (Plate I, figs. 4 and 5).

Two ♂♂ (one determined by W.H.T. Tams of the British Museum), one ♀; 22.xi.26, Um Arad (Sinai) (leg. Kaiser), (A.A.), somewhat redder than Klug's type which came from the Alexandria vicinity.

An Eremic species, inhabiting North Africa, Sinai and perhaps Palestine and Arabia.

The data for *decolorata* Klug given by Andres-Seitz (1924) do not belong to *Lambessa decolorata* Klug, but to *Dendrolimus alfierii* Andres-Seitz.

61. *Lambessa pungeleri* Stertz (= *albescens* Roths.) (Plate I, fig. 3).

One ♂, 17.x.17, Suez Road, Eastern Desert (A.A.).

May be distinguished from *decolorata* by its smaller male antennae and paler forewing; from *Lasiocampa serrula* f. *davidis*, with which it flies, its brown hindwings will easily distinguish it.

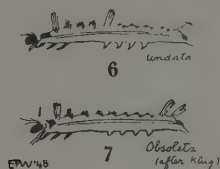
A univoltine autumnal species. Eremic, ranging from North Africa to Palestine.

62. *Anadiasa undata* Klug.

A few words are necessary about the generic name of this moth. The genus has evidently been confused in the past with *Nadiasa* Moore (see No. 65 below) and its name has during this time been spelt in various ways by various writers. However, Aurivillius (Seitz, XIV) and Rebel used it spelt *Anadiasa* for *undata* and *obliquata* Klug and it is therefore the valid name for these two moths. It is a small Eremic genus with rather small dull moths but gaily-coloured lackey caterpillars attached to various species of *Acacia* tree, ranging from Arabia and the Sudan and Egypt to Morocco, and to South Africa.

I may also be mentioned that the Libyan species, *Anadiasa incerta* Kruger (1939), which feeds on *Acacia tortilis* is certainly congeneric by Kruger's own diagnosis. I suppose Kruger had no examples of *undata* and *obliquata* to hand when describing *incerta*, and was puzzled by the generic diagnosis given in Seitz, Vol. II.

There has also been some doubt whether Klug's two species, *undata* and *obsoleta*, are in fact two species, or only one. Klug described *obsoleta* from « Nubia and Upper Egypt » and illustrated in colour its early stages. He described *undata* from « Nubia, between Syena and Suckot » and only illustrated a large female adult. Later authors, doubtless rightly, have iden-



Figs. 6 and 7 : *Anadiasa* larvae : (6) *undata* Klug, (7) *obsoleta* Klug, as shewn in Klug's plate.

tified the common species of Cairo and the Nile Delta and valley as far as Aswan as *undata*. The larva of this moth differs from Klug's figure of *obsoleta* larva as shown (cf. figs. 6 and 7) and if Klug's plate is accurate this difference is enough to assure us that the two species are in fact distinct. Klug's text however does not mention the two hind tufts or pencils which are the principal criterion of the *obsoleta* larva as illustrated.

Since *undata* larva has not been described before, the following detailed description of the early stages is appended (E.P.W.).

The egg is glossy, bright green; smooth, flat-oval, with a slight lateral depression, becoming glaucous green later, so that under a microscope a cluster resembles a bunch of dessert grapes, with a pale green disc at one end of each egg containing a dark glaucous green central point. Laid in

irregular clusters they hatch, in August, on the seventh day. When empty the shell is iridescent like a soap bubble.

The freely hatched larva is grey-green, with a glossy black head, whitish downy hairs, a darker lateral area, and enlarged black tubercles on the thoracic somites and also on somites 6, 10, and 11; on the others, the tubercles are black but of normal size.

In the third instar the dorsal area is white with black central transverse marks and there is a pale blue black-edged lateral stripe. The sublateral and ventral areas are dirty olive-white with oblique lateral and transverse ventral black marks. There are conspicuous dorsal pencils on somites 2, 6 and 11. The head is blackish, somites 1 and 12 are broadly bluish above. The thoracic feet are black, the abdominal feet are striped with black. The hairs are pale yellow.

The fourth instar resembles the third, but the dorsal area is now orange; somites 1-6 are dorsally suffused with sooty grey, and somites 1 and 12 are black above.

In the fifth and final instar the caterpillar is coloured as in Klug's plate of *obsoleta* but the dorsal area can be almost completely orange-suffused or with a clear dorsal white chain, with islands of pale blue, freckled with black, edged thickly with black. In the former case, conspicuous black setae are to be seen. There are thick prominent pencils on somites 2, 6 and 11, but Klug's plate of *obsoleta* shows pencils on 2, 10 and 11. On somites 2 and 3 are white oblique dashes with an anterior black edging. The head is matt blue-black, freckled with black. For other details, see Plate VI, figs. 1 and 2.

The foodplant is only *Acacia nilotica*. I have found the larvae of the Cairo district so strictly monophagous on this species of tree that they have died rather than touch five other kinds of *Acacia* offered. Hayward has described its habits on the Acacias of Aswan.

The papery cocoon is oval, fairly firm, and in captivity is spun on twigs; according to Hayward it is more often spun under stones wild.

In October at Cairo the pupal period is one month; November pupae overwinter in the north. Further south the moth flies all the year round, e.g. Aswan (Hayward); cf also two males taken at Kom Ombo on 15.xii.11(A.A.).

An Eremic species, perhaps ranging westwards to Morocco.

63. *Chilena obliquata* Klug.

One ♀, 25.vi.22, Deirout, Beheira (A.A.). One ♀, 1.ix.19, Montaza, Aboukir Road, near Alexandria (P.). These two specimens are similar to each other, except that Petroff's is more rubbed; yet the former was described in Andres-Seitz (1925) as the Central-Asian species *sordida*

Ersch.. It does not agree perfectly with what Klug says of *obliquata*, for the costa and outer margin are not yellowish, but it certainly agrees better with Klug's plate of *obliquata* than with available plates of *sordida*; in particular it lacks the pale discal spot of *sordida*; it seems safest therefore to delete *sordida* from the the Egyptian list, and regard both these specimens as *obliquata*.

64. *Dendrolimus alfierii* Andres-Seitz (Plate I, figs. 6 and 7).

Inhabits the Eastern Desert; not known yet from elsewhere. Adults have been taken to light or reared in iv, vi, vii, viii, xi and xii. The species is therefore multivoltine.

The female, which is not yet described, is illustrated in the coloured plate.

The larval period is about six weeks, the pupal period about two weeks, though doubtless both are somewhat longer in the cooler season.

A description of the larva (Plate I, fig. 8), pupa and cocoon follows :

Larva : Of lappet-caterpillar form, and grey-brown ground-colour, with long pale ochreous hairs on the sublateral lappets. The head bears short pale hairs and is either ochreous near the mouth, pale-purple brown above, and white-rimmed behind, or else more unicolorous dark brown. Dorsal line, interrupted, dark with pale ochreous edge. Subdorsal stripe, on abdominal somites broad and white and interrupted close to the black warts with black and red marks on each somite. On somites 2 and 3 are transverse brick-red swellings, concealed when at rest but exposed when alarmed or preserved. Spiracles, black-rimmed. Underside and abdominal claspers, yellowish with deep brown markings.

The glossy brown pupa is enclosed in a flimsy transparent cocoon

Foodplant : *Zygophyllum coccineum*.

An endemic Eremic species.

65. *Nadiasa acaciae* Klug (Plate VI, figs. 3 and 4).

Tams has shown, in *Nov. Zool.*, XL (1936), that *Taragama* is a synonym of *Nadiasa* Moore; the latter name must therefore be used for this well-known genus.

This beautiful species has its headquarters in the Nile valley and delta, where it is an oasis moth; in Tripolitania however it appears to inhabit drier country, being there known on *Acacia tortilis* and *arabica*. In Egypt it has only been remarked on *Acacia nilotica*. It appears to be absent from the extreme north of Egypt, and to extend southwards to Aswan. It is multivoltine.

A North-African Eremic species.

66. *Nadiasa repanda aegyptiaca* Bang-Haas.

Commoner in the North of the Delta and around Alexandria than elsewhere in Egypt, but doubtless occurring southward up the Nile valley, for Rebel (1916) has reported it from the Sudan. It may be taken in almost any month of the year, being multivoltine.

Foodplants : *Robinia*, various fruit trees including *Citrus* and *Psidium* (Guava).

An Eremic species, discontinuously distributed from Spain and Morocco to Central Asia.

Family : LEMONIIDAE

According to Hampson (*Trans. Ent. Soc.*, 1901) the name for this family cannot be taken from its one Palearctic genus *Lemonia* Hubner, for as a family-name *Lemoniidae* or *Lemoniadae* is a homonym of a South American butterfly family derived from the generic name *Lemonias* Westw. Nevertheless I prefer to retain the name *Lemoniidae* rather than, with Hampson, say *Sabaliidae*. This moth-family has always been regarded as very primitive, but Börner has placed it next to but in advance of *Lasiocampidae*. There still seems very good reason to regard it as a primitive family and it is here therefore placed after *Lasiocampidae*.

67. *Lemonia philopalus* Donz.

Only known from the Mariout in xi and xii.

Polyphagous on low plants at night, univoltine autumnal.

A Mediterranean steppe species ranging from Spain along the coast of North Africa.

Family : SPHINGIDAE**Sub-Family : Acherontiinae****68. *Acherontia atropos* L.**

Adults in v, viii, ix and x, from Cairo, Alexandria, etc.. Doubtless also further south, probably only in oases.

Foodplants : *Solanaceae* (potato, jasmine, etc.).

Multivoltine. Fond of entering bee-hives.

A Tropical species, principally African, migratory.

69. *Herse convolvuli* L.

This large moth flies in all months except the coldest and from north to south. It has not yet been taken in the desert, but being a migrant, might be taken there.

Foodplants : *Chrysanthemum*, *Convolvulus*, etc..

Multivoltine. Tropical, Old World.

Sub-Family : **Philampelinae****70. Deilephila nerii L.**

All the year round, from north to south; an oasis moth.

Foodplants : *Nerium*, *Vinca*.

Multivoltine. Tropical, Old World. Migratory.

71. Macroglossum stellatarum L.

Probably all the year round, inhabiting Egypt from North to South, in the Mariout and the Nile valley.

Foodplant : *Galium*.

Multivoltine. Fond of entering houses and exploring cliffs for holes.

- A Euroriental migrant.

Sub-Family : **Ghaerocampinae****72. Celerio lineata livornica Esp.**

Distributed from North to South; also Sinai.

Foodplants : *Asphodelus tenuifolius* and other low plants; also cotton, vine, etc.

Swarms of the caterpillar sometimes occur in spring in maritime steppe-desert terrain. It flies all the year round at Aswan, where another migrant (*Vanessa cardui* L.) does the same. In the North however it seems not to have been remarked between vii and xi. This suggests that it migrates northward out of Upper Egypt for the summer and early autumn, or southwards with the prevailing north wind to the Tropics where summer rains fall. It is however hard to see why it should occur in rainless Aswan and yet not have been noticed in Cairo in late summer.

A Tropical-Subtropical migrant of the Old and New Worlds.

73. Celerio euphorbiae mauretanica Stgr.

Eight adults, all rather white, also two larva skins with data : « larvae on *Euphorbia*, Wadi Araba (Galala), collected 23-27.iii.28; adults hatched 23-30.iv.28; in captivity the larvae at first fed on mulberry; later they accepted readily the field *Euphorbia* called Lebain, Malaka, or Zagalouda » ; (A.A.). The species however, not only inhabits the Eastern Desert but the Mariout and Sinai, as the following material shows : Five, similar form, from larvae hatched late viii.21 and 29.v.22, Sidi Bishr (i.e. East of Alexandria) and Aboukir Road, near Alexandria (P.). One, hatched 22.v.40 from larva, Wadi el Rabaa, 1400 m., S. Sinai (A.A.) is f. *deserticola* Bart.; a chrysalis from the same locality produced another adult (not available for inspection) hatching on 24.ix.40, an apparent example of pupal diapause.

In the larval skins, the black parts are very much spotted with white. In one, the black patches are separated by the reddish dorsal stripe, and

by broad yellow lateral and sub-lateral stripes; in another, the black is more extensive, and the yellow stripes smaller. There is but one row of eye-spots, i.e. subdorsal.

A Euroriental species, with migratory tendencies, which however in Egypt never seems to leave its desert habitat.

74. *Hippotion celerio* L.

Flies all the year round, from North to South, inhabiting oases. Its migratory habits however may lead to its being seen also in the desert.

Foodplant: *Vitis* (vine).

Multivoltine, the pupal period being ten days in summer. An Old World Tropical migrant.

75. *Theretra alecto cretica* Boisd.

Known from the Cairo and Alexandria vicinities.

Odd specimens occur in almost any month of the year but in the main the moth is bivoltine, according to Carneri (1937) (*Miscell. Ent.*, XXXVIII, No. 4).

Foodplant: *Vitis* (vine).

Both this and the preceding species can cause economic damage thereon.

A Tropical Asiatic species also inhabiting the East Mediterranean.

Super-Family : AGROTOIDEA

Family : AGROTIDAE

Group I : Trifinae

In this group I follow Boursin's (i.l.) arrangement which he hopes to publish shortly. I am much indebted to him for assistance in identifications.

Sub-Family : Agrotinae

76. *Euxoa anarmodia* Stgr.

Inhabiting the Mediterranean coast of Egypt, this moth has not been taken far inland. Of variable aspect. Two examples both bred from larvae on *Ilyoscyanus muticus* at El Arish, North-East Sinai. 20.ii.27; one pupated 10.vi.27 and hatched 28.vi.27; the other hatched on 10.vi.27. Some larval skins have also been preserved; they are very lightly pigmented.

Doubtless this species also inhabits the Mariout.

An East Mediterranean coastal species.

77. *Euxoa canariensis diamondi* Boursin.

Twelve (5 ♂♂, and 7 ♀♀), iv.40, 390-1500 m., Wadi Isla, Bir Tarfa and Karm Alam, all localities near Gebel Katherine, South Sinai; also one, 31.iii.24, El Migreh, North-East Sinai; a further example, from Wadi

Magnas, Sinai, 13.iv.24, was sent to the British Museum where Mr. Tams did not succeed in identifying it; this example is still in London. (A.A.).

A univoltine vernal desert moth, of Eremic range : from the Canaries to South Persia.

78. *Agrotis crassa golickei* Ersch.

Flies in the Mariout in x. Inhabits steppe and often oasis too.

A univoltine autumnal moth, of Euroriental range. This race is the Eastern race which extends into Persia.

79. *Agrotis spinifera* Hubn.

Widespread in Egypt, commonest in oases. At Aswan, Hayward found it common all the year round. It is multivoltine. Its larva has been found on *Arundo* near Ghizeh (A.A.). There are also specimens from Bir Odeib (shores of Gulf of Suez) and Wadi el Ghedeirat, N. Sinai (leg. Rabinovitch) (A.A.).

A widespread Asiatic Tropical species, probably migratory.

80. *Agrotis segetum* Schiff.

Four, taken in iv, v and vii, in Shubrah (near Cairo) and North Sinai (A.A.). At Aswan, Hayward found it common from iii to vii and again in x. It also occurs along the North Coast. Inhabits oasis and steppe, but perhaps not desert.

A Euro-Siberian and Asiatic-Tropical species, perhaps migratory. It is a well known root-crop pest.

81. *Agrotis trux nili* B.-Baker. *

Probably *A. adolfi* Draudt is a mere synonym. Krüger (1939) thought the latter *arens* Turati, but this is a form of *ripae* (see below) a quite different species.

On the whole a very uniform series, except for one variety from Deirout.

Inhabits the Mariout and the Delta and Nile valley around Cairo, perhaps further south too.

According to Andres-Seitz there are two species, *nili* and *trux*, of which the latter is bivoltine, flying also in iv, and the former being a desert moth. I rather doubt this but do not positively gainsay that there are two species.

A Eurooriental species ranging from the British Isles to South Persia.

82. *Agrotis puta* Hubn.

Inhabits the Mariout, the Wadi Natroun, the Nile valley southwards to Minieh, and also the mountains of Southern Sinai (Wadi Isla, 13.iv.40, 1430 m.) (A.A.).

Flies in two broods, ii-iv and x-xii. The commonest form is *lignosa* God.

A Eurooriental species.

83. *Agrotis herzogi* Rebel (Plate I, fig. 9).

Boursin has now established that this species differs from *haifae* Stgr. by having less strongly pectinated male antennae and from the following (*sardzeana* Brandt) not only in its darker colouring but the more spatulate harpes on valvae and the differently-formed juxta. It is a very variable species and I see little difference between the Arabian, Egyptian and Saharan races, though the name *saracenica* Tams has been applied to the former and the names *securifera* Turati (Tripoli) and *hoggari* Roths. (Algeria) to the Saharan.

A long series spread over the cooler months between x and iv; there is probably only one brood annually and the emergence depends on various factors, though perhaps the species is bivoltine. It inhabits the Cairo district (oasis biotope), the Eastern Desert and Sinai (desert, steppe and desert-mountain biotopes).

An Eremic species ranging from the Western Sahara to South Persia.

84. *Agrotis sardzeana* Brandt (Plate I, fig. 10).

(Mitt. Muench. Ent. Ges., XXXI, Heft III, p. 840, Pl. XXIII, fig. 6, 1941).

This recently-described moth has not been recorded before from Egypt, nor apparently has it been taken before 1947. It is paler than the foregoing species, and decidedly more beautiful, being coloured with various shades of white, ochreous, and grey, doubtless well adapting it to its sandy habitat. It also differs slightly in structure.

Seven, 2.xi.47, sandy desert near the Giza Pyramids (E.P.W.). Its phenology is probably like that of the foregoing except that it has not yet been taken so late in the spring; indeed it may not have ever been taken in the early months of the year but Brandt (loc. cit.) is not explicit.

An Eremic species distributed from the Western Sahara to South Persia.

85. *Agrotis ypsilon* Rott.

All the year round, everywhere.

A larval skin, marked « common, bersim fields, Giza » (A.A.).

A Tropical-Holarctic migratory pest. For its life history see coloured plate X in Willcocks and Bahgat, 1937.

86. *Agrotis ripae alexandrensis* B.-Baker.

Boursin thinks the names *weissenborni* Freyer and *desertorum* Boisd. cannot be used for the Egyptian race, since they apply especially to other races. The Egyptian race has two different forms, with identical genitalia: a robust white form, for which some have used the name *weissenborni*, and a sligher ochreous form. Both vary somewhat, and they are not seasonal forms. The name *arens* Turati may be permissible for the white form, but the population as a whole must go by Bethune-Baker's name.

Four, smaller and ochreous, 27.x.16 and 12.xi.14, Amrieh (Mariout) (leg. Boyd) (A.A.), and 23 and 27.x.16, Mohammédiya, North-West Sinai (leg. Boyd) (A.A.). Also taken by Petroff at Ikingi-Mariout, and Ramleh (Alexandria), in ix. Also from the Wadi Natroun (see Andres-Seitz).

Two, robuster and whiter, 30.iv.25, Dekeila (Mariout), and 14.xi.22, Ramleh (Alexandria) (A.A.).

A halophile moth, occurring along the beaches of Northern Egypt and also, as in the Wadi Natroun, on saline desert inland.

A Euroriental species, ranging from Britain to Mongolia.

87. *Agrotis* (subg. *Powellinia*) *lasserreii* Ob.

Flies in the Mariout in x, xi and xii (P.). Also, less commonly in the Eastern Desert, for there is also one : 18.ix.22 Wadi Digla (A.A.). In some countries it is found in woody hill country or on oasis biotopes as well as steppe and desert.

A univoltine autumnal species. Pan-Eremic, ranging from Morocco to Central Asia.

88. *Agrotis* (subg. *Powellinia*) *pierreti* Bugn. (= *marsdeni* B.-B.).

Inhabits the Mariout, flying in ix, x and xi.

A univoltine autumnal moth. An Eremic species ranging from Morocco to South Persia.

89. *Ochropleura* (subg. *Dichagyris*) *imperator* Bang-Haas.

Inhabits the Eastern Desert and Sinai, flying in iv. There is a long series from the Wadi Gerrawi and from various heights in the mountains of South Sinai (A.A.).

One is labelled : hatched 20.v.18 from larva on *Zygophyllum* (Wadi Gerrawi).

A univoltine vernal species. Eremic, ranging from Algeria to North-West Arabia.

90. *Ochropleura* *forficula* *erubescens* Stgr.

Only at over 1000 m. in the mountains of South Sinai : there however it comes commonly to light in iv (A.A.).

Univoltine vernal. Range : (?) Euroriental.

91. *Ochropleura* *flammatra* *centralasiae* Wagn.

Two, 23.v.35, El Kosseima, North Sinai, leg. Rabinovitch (A.A.).

Bivoltine, the second brood (not yet taken in Egypt) being autumnal. Range : Euroriental.

92. *Lampra* (*Triphaena*) *proruha* L.

Inhabits the Mariout, the Delta and Cairo district. Most specimens

were taken in iii or iv, but there are also some from the Mariout taken in viii and ix.

Polyphagous, but often attacking garden vegetables and root crops, sometimes a pest. Euroriental, and somewhat migratory.

Sub-Family : Hadeninae

93. *Scotogramma trifolii* Rott.

Occurs everywhere in Lower Egypt, including the Fayoum and Sinai, though not very common. Phenology, somewhat irregular, for April pupae in the Fayoum bred by Andres emerged partly in May and partly, after aestivation, in October.

Food plants : *Schanguinia baccata*, lentils, (?) *Peganum harmala*. and probably various kinds of *Chenopodiaceae*, on which it is known to feed in other lands.

Palaeo-Tropical-Holarctic.

94. *Cardepija albipicta afra* B. Baker

Flies in the Mariout, in iii, iv and ix, x, xi (P.). There is also a male labelled 18.xii.25, Bahariya Oasis (Libyan Desert) (A.A.).

Apparently bivoltine. Pan-Eremic.

Rebel (1909) also reported *C. irrisor* Ersch. from Sinai; and Andres-Seitz (1923) record *Scotogramma sodae* Ramb. from the Mariout in XI; it would be necessary to examine the original specimens to be sure what these were.

95. *Pronotestra silenides* Stgr.

One ♂, 12.iii.37, Wadi Um Mitla (Sinai) (A.A.). Also some specimens from the Mariout mixed with the next species (*silenes*) (P.). (see figs. 8, 9 and 10, and also the footnote on the next species).

A univoltine vernal species. Eremic, ranging from Spain, North Africa to South Persia.

96. *Anepia silenens sancta* Stgr.

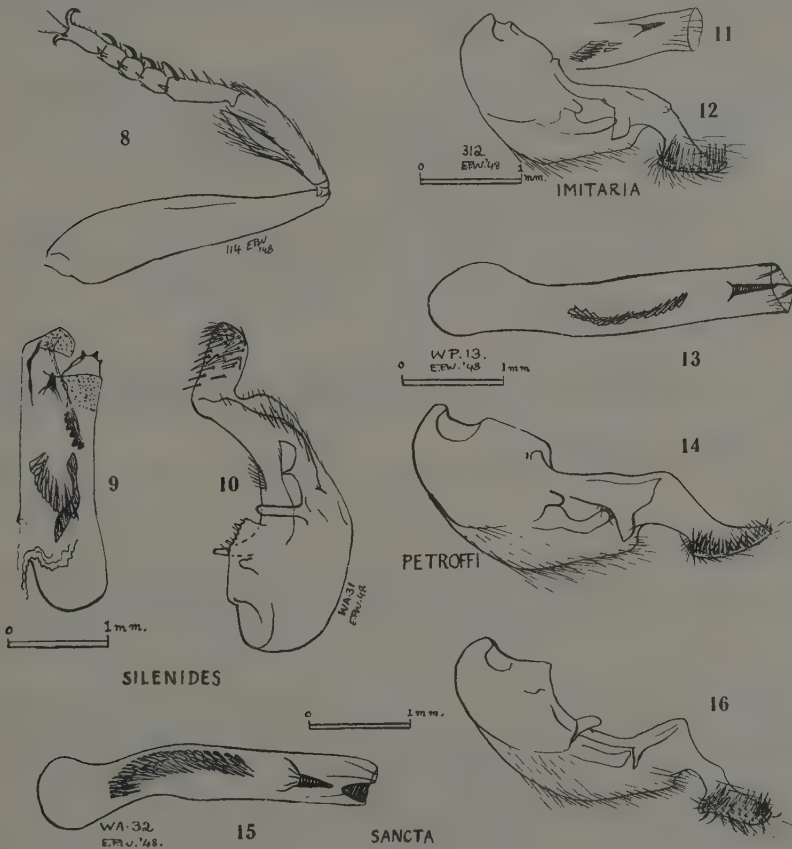
Mariout, i and ii (P.); also Ramleh, Alexandria, in iii (A.A.). (see figs. 15 and 16 for male genitalia).

Univoltine vernal. Mediterranean.

96a. *Anepia imitaria petroffi* subspec. nov.

Possibly *Harmodia imitaria* Brandt (Not. Ent., XXVII, 20.xi.1947, Helsingfors) which is obviously congeneric with *Anepia silenens* Hubner, occurs in Egypt. A specimen of it, identified by male genitalia, occurs in Petroff's series of "*Epia silenens*" from the Mariout. Petroff's catalogue i.l. says there are four "*silenens*", all taken in Egypt. In fact his series, without labels on individual specimens, consists of five moths, of which one is f. *sancta* of true *silenens*, three are *P. silenides* (No. 95) and one *imitaria* Brandt. This example is a worn specimen, rather pale, of a brown and white coloration. It is somewhat larger than the paratype of *imitaria* which Brandt kindly sent me. The markings are identical but the coloration is very different. I describe it as *petroffi* forma nov. probably the East Mediterranean race of Brandt's

new species. I think it is probably Egyptian, but perhaps Palestinian; Petroff's omission to label his specimens is indeed regrettable! It does not agree in colour with *cinochrea* Chrét., as described in Seitz III, Suppl. ("small, pale grey"). Of *cinochrea* Brandt wrote in his description of *imitaria*: "I must mention here that I have not seen *cinochrea* Chrét., described from Gafsa, North Africa. Draudt who also could not examine this African species, regarded the name as a synonym to *sancta* Stgr., Oberthur as a *silenes* Stgr., and Rothschild



Figs. 8-16 : Distinctive characters of *Anepia silenes* Hubn., and its mimics : (8-10) *Pronotebra silenes* Stgr., (8) fore-leg, (9) aedeagus, (10) right valva; (11 and 12) *Anepia imitaria* (Brandt) [Para-Type : Persia]; (13 and 14) *Anepia imitaria petroffi* subsp. nov.; (15 and 16) *Anepia silenes f. sancta* Stgr. [Egypt]; (11, 13, and 15) aedeagus; (12, 14 and 16) right valva (the anterior lateral view of the valve is given).

thought it a *silenes* Hubn.". However, Boursin has recently examined the type of *cinochrea* critically and found it to be *silenes*. The genitalia of the three relatives, *silenes sancta*, *imitaria* para-type (from Persia), and *imitaria petroffi*, are shown in figures 11-16; I consider the slight differences in genitalia between *petroffi* and *imitaria* as of probably subspecific value only; it will be noticed that the *petroffi* tail-parts are larger than the *imitaria* type and the aede-

gus-tip somewhat different, though not so strikingly different as that of *silenes*. The genitalia of *silenides* (No. 93) are also shown for comparison (figs. 9 and 10); this is not so close a relative, though, as mentioned above, it has been confused in the past. It is usually placed in a different genus on account of the clawed fore-tarsi (fig. 8), etc.

97. *Aglossestra deserticola* Damps. (= *mariae-ludovicæ* Lucas).

Flies in the Mariout in xi (P.). Was originally described from Suez
A North-African Eremic species.

98. *Hadula gigantea* (Rebel).

Originally described from Sinai. Recorded by Petroff from the Mariout in his catalogue i.l., but the specimen is mislaid or disposed of.

A North-African and South-West Asiatic Eremic species.

99. *Miselia* (*Polia*) *consanguis* Guen.

Specimens from the Alexandria and Cairo districts, in iii, iv, v and xii. It has been bred from a larva found on cultivated mallow (*Lavatera*) (A.A.).

Probably multivoltine but with some kind of aestivation.

A Palaeo-Tropical species.

(Note that the previous record of *Polia peregrina* Tr. has to be deleted, the specimens being in fact *Crino compitalis* Draudt and *Sidemia discordans*, for which see Nos. 116 and 131).

100. *Euterpia laudeti* Bois.

Inhabits the Eastern Desert and Sinai, flying in iii and iv. A Euroriental species.

101. *Leucania loreyi* Dup.

Everywhere, all the year round, but scarcer in midsummer. It has been bred from larvae on maize (A.A.), but of course eats grasses too.

Multivoltine. Palaeo-Tropical, probably migratory.

102. *Leucania zeæ* Dup.

Three, 15.xi.15, Beni Suef (Upper Egypt); 7.viii.17, Maadi (near Cairo); 1.vii.25, Ramleh (Alexandria) (A.A.). Also one 29.x.11, Mariout (P.) recorded in his catalogue i.l. but specimen not seen. Also recorded from Miniya (Upper Egypt) by Storey (1916).

The phenology seems multivoltine, and it probably only breeds on oasis biotopes. Euroriental.

103. *Leucania putrescens* Hubn.

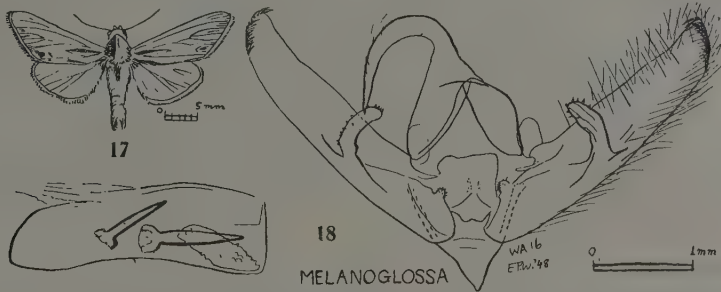
One ♀, Cairo, 27.ix.46 (E.P.W.). Reported from Port-Said by Storey and from the Delta by Andres-Seitz (1923), both in the autumn. There is probably also a spring brood, since in other parts of its range this has been noted, the moth being bivoltine, and feeding on grasses.

A widespread Mediterranean species, reaching the South Coast of Britain in the North-West and South Persia in the East.

Sub-Family : *Cuculliinae***104. *Pseudocopicucullia melanoglossa* (Berio) (fig. 17).**

(*Pseudonycterophaeta melanoglossa* Berio, 1934, *Boll. della Soc. Ent. Italiana*, LXVI, No. 6, XII, pp. 124-6, figs. 1-2).

One ♂, 14.xi.15, Sheikh Fadl (Upper Egypt) (A.A.). The genitalia of this example are illustrated (fig. 18).



Figs. 17 and 18 : (17) *Pseudocopicucullia melanoglossa* (Berio); (18) ♂ genitalia, ventral open view, with aedeagus separated.

This appears to be the second known example of this rare moth; the first was taken in the Fezzan (Ubari), Libya.

An Eremic species of the Sahara.

105. *Pseudocopicucullia syrtana* Mab.

Flies in winter in the Eastern Desert and probably also in Sinai and elsewhere, in the desert.

A univoltine vernal species. Eremic.

106. *Cucullia wredowi judaeorum* Strand.

Flies between November and March in the Mariout and also Southwards to near Cairo. A steppe and oasis moth.

Foodplant observed in Egypt : *Chrysanthemum coronarium*.

Univoltine vernal. A widespread Mediterranean species also inhabiting steppes, and a very close relative of the more northerly *chamomillae* Schiff., as which it was at first mentioned from Egypt.

107. *Cucullia strigicosta* Boursin.

One example bred from a larva found on *Scrophularia deserti* in the Wadi Murra (Eastern Desert) on 27.iii.25 hatched on 23.iii.26. Also a larval skin with similar data; (A.A.). A further example, 9.ii.25, Tih Plateau, Sinai (leg. Clayton) (A.A.).

Univoltine vernal.

These are the first captures in Egypt of a species hitherto known only from Khaniqin in Iraq. They were actually taken about ten years before the types, but were not recognised as new when caught. The species is not known elsewhere. The Iraqi locality has a heavier rainfall and a steppe-desert vegetation; the *Scrophularia* there grows on crests of ridges. In Egypt, however, owing to the greater aridity, the *Scrophularia* only grows in valley-bottoms, the convexities being quite bare. This species therefore is an interesting example of how one species adapts itself to different habitats at different points in its range. How wide this range is, is still uncertain; perhaps it is interrupted, for at Hail, in Central Arabia, where if any species of the *C. verbasci* group should occur one would expect it also to be *strigicosta*, the group is surprisingly represented by a different species, *anceps* Stdgr., an otherwise Anatolian-Iranian montane species. These Hail specimens were taken by the Anti-Locust units and I have examined them critically.

108. *Metlaouia oberthuri* Deck.

Two, xii.17, Ikingi-Mariout (P.). Petroff considered these to be *Ps. sylvana* (No. 105). They agree well with the plate IV of Turati's article.

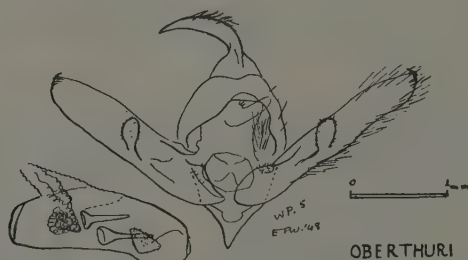


Fig. 19 : *Metlaouia oberthuri* Deckert (♂ genitalia, ventral open view with aedeagus separated).

in *Atti Soc. Sc. Nat.*, LXI, fig. 7. The male genitalia are illustrated here-with (fig. 19).

A univoltine winter species of North African Eremic range.

109. *Brachygalea albolineata* Blach.

One, 10-12.iv.40, Wadi Isla, Karm Alam, 680 m., South Sinai; one 9.ii.25, Tih Plateau, Sinai (leg. P.F. Clayton); (A.A.).

A univoltine vernal moth of Eremic range, from North Africa to South-West Asia.

110. *Lithophasia quadrivirgula* (Mab.).

Flies in the Mariout from x to i. A univoltine autumnal species, inhabiting steppe deserts in North Africa and South-West Asia.

111. *Cerapoda aegyptiaca* Joannis.

One, hatched from a larva found on 13.x.23 at 2nd Tower, Suez Road Heliopolis (foodplant: *Zilla spinosa*), hatched 23.xi.24 (A.A.). The larva is described in Andres-Seitz (1923). Considering the prevalence of the foodplant in the parts of the Eastern Desert bordering Cairo and Helwan, this moth is surprisingly rare.

It is a univoltine autumnal insect, endemic to Egypt, as far as is known at present.

112. *Metopoceras khalildja gypsata* Turati.

Flies in the Mariout in i and ii.

A univoltine vernal species inhabiting the steppes along the North African Mediterranean coast.

113. *Metopoceras omar* Ob.

Flies in the Mariout in ii and iii.

A univoltine vernal moth, inhabiting deserts and steppes from North Africa to South Persia, and Turkestan. Pan-Eremic.

114. *Metopoceras spec. near canteneri* Dup.

Five specimens, iv.40, 390-1500 m., South Sinai (A.A.).

Recorded in Wiltshire (this Bulletin, 1947) as *canteneri* Dup., but see Addendum.

115. *Cleophana chabordis* Ob.

Stated by Andres-Seitz (1923) to be scarce in the Mariout. Apparently commoner in South Sinai, whence there is a series taken in iv between 390 m. and 1500 m. (A.A.).

An Eremic species, ranging from North Africa to South Persia.

116. *Crino compitalis* (Draudt).

Commonest on the North Coast, and not known south of Cairo. Flies in xi and xii. Some specimens have been correctly named, but others have been reported as *Polia peregrina* Tr., a Euroriental moth not inhabiting Egypt. The two are superficially strikingly similar, but one is a Hadenine (i.e. has hairy eyes) the other a Cuculliine (smooth eyes with lashes); the genitalia also are quite different. The Egyptian species extends westwards along the North African coast at least into Cyrenaica, where it is more variable and was described as three (!) new species by Turati. The genitalia were illustrated by Boursin in Figure 1, Plate III, *Revue Française d'Entomologie*, X, 1943.

A univoltine autumnal species.

117. *Antitype juditha* Stgr. (Plate VI, fig. 6).

One, 28.xii, 24, Wadi Watir, Sinai (leg. P.F. Clayton) (A.A.).

The genitalia are also illustrated (fig. 21).

A univoltine autumnal species ranging from Palestine apparently to South-West Arabia, according to Warnecke (1937).

118. *Eumichtis lea* (Stgr.).

For the re-definition of the genus *Eumichtis*, see Boursin, 1940 (*Mitt. der Muench. Ent. Ges.*, XXX, pp. 511-513).

The species *lea* was not previously known from Egypt, being hitherto misidentified by Andres-Seitz (1925) as *Derthisa trimacula unicolor* Dup. The actual specimen to which these authors refer has been re-examined and the above determination was reached from the male genitalia. The spe-

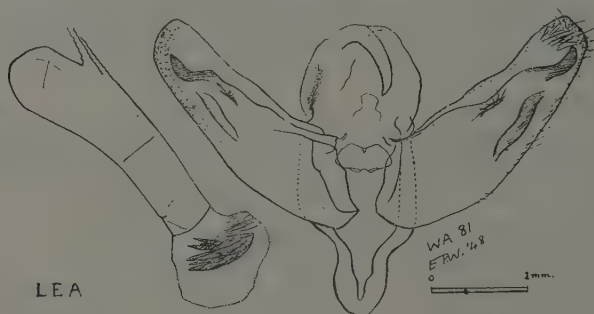


Fig. 20 : *Eumichtis lea* (Stgr.) (♂ genitalia, ventral open view, with aedeagus separated).

cimen (labelled 18.ix.22, Wadi Digla, near Maadi, Eastern Desert; A.A.) is actually almost unrecognisable except by dissection, being rubbed and chipped; in fact it is not superficially separable from a small pale example of its following congener (No. 119).

The genitalia of this species are shown (fig. 20).

The species has hitherto been known only from Palestine, but it is already evident from the Cairo material that Eremic Palestine is faunistically continuous with Sinai and the Eastern desert of Egypt, and this moth is just another example of this affinity.

119. *Eumichtis aurora aegyptiaca* Wilt.

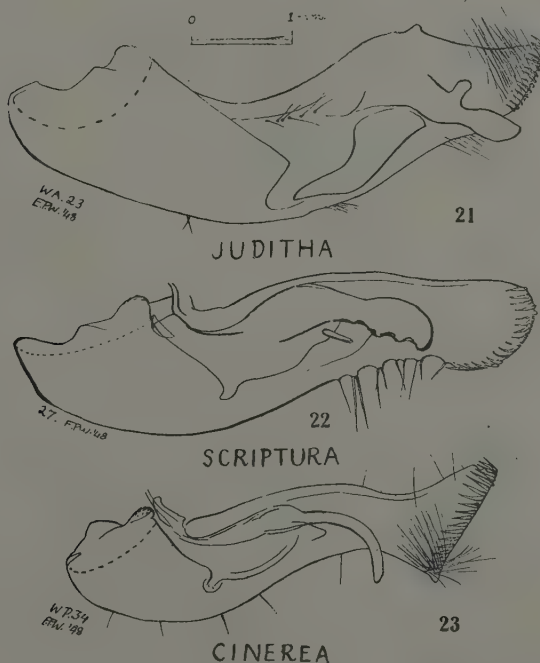
Described in last year's Bulletin with illustration of two adults and the male genitalia. To that description may be added one qualification : the forelegs are sometimes pigmented; it is the mid-legs and hind-legs that consistently lack the pigmentation typical of the Cyrenaican and other more western forms. In addition to the types and para-types from the

Eastern Desert detailed in the description can now be mentioned three females (para-types), 1 and 13.xi.47, desert near Helwan (E.P.W.), now in my collection. Also, one of the para-types (viz. that from Wadi Ascar) is in fact not conspecific and must be deleted.

Univoltine autumnal. An Eremic North African moth.

120. *Aporophila cinerea* Stgr. (= *cyrenaica* Turati).

Probably the only member of this genus to occur in Egypt is the above-named. The Eastern forms considered thirty years ago as « varieties » of *A. australis* Boisd. have now been found to be three separate species. A specimen in coll. Alfieri, identified as *A. australis*, proves to belong to a different genus and is in fact a new species (No. 132 below). Andres-Seitz (1923) recorded « var. *scriptura* Freyer » from the Mariout, a form which is specifically distinct from *cinerea* Stgr.; both occur in Palestine and it is not impossible that *scriptura* (= *ingenua* Freyer) may yet be found to inhabit Egypt, Sinai being its most likely locality; at present however I prefer to omit it. The Mariout species proves, on investigation to be *cinerea*.



Figs. 21-23 : Right valve, interior lateral view, of (21) *Antitype juditha* Stgr., (22) *Aporophila scriptura* Freyer, and (23) *Aporophila cinerea* Stgr.

of which there were five taken at Ikingi-Mariout in xii by Petroff. The genitalia are shown (fig. 22) and those of *scriptura* (fig. 23) for comparison.

An East-Mediterranean univoltine autumnal moth.

(Next in taxonomic order come three old records of which one is certainly and two are probably to be deleted, viz: *Conistra vaccinii seabdouensis* Aust., *Atethmia xerampelina maculifera* Stgr., and *Cosmia ocellaris pallego* Hubner. None of them is a migrant.

As regards *sebdouensis* Aust., it must be first noted that Austaut's form is in fact an Algerian race of *Conistra rubigo* Ramb. (see Boursin, 1943, *Mem. Mus. Hist. Nat.*, Paris, XVIII, fasc. iv; Y. de Lajonquière and C. Boursin "Sur une *Conistra* nouvelle de la Faune Atlanto-Méditerranéenne"), and not *vaccinii* at all. This fact was of course unknown to Draudt, who was responsible for this identification, in 1910. No locality is given in the record. In default of the one specimen taken by Ferrante, it is hard to guess its real identity, but that it was *vaccinii* seems quite impossible and that it was *rubigo seabdouensis* unlikely, in view of the fact that the woodland or scrub vegetation, to which, in Mediterranean lands, the genus *Conistra* is, as far as I know, confined, occurs nowhere within the boundaries of Egypt.

As regards *xerampelina maculifera* Stgr., the Syrian race of a species well-known to me in its three different races, this moth is particularly attached to *Fraxinus* and *Amygdalus* trees; in fact however, I have never known the species to inhabit ground where only *Amygdalus* grew, and undoubtedly *Fraxinus* is the principal foodplant over most of its range, if not all. *Fraxinus*, the ash tree, does not grow naturally in Egypt, as it does in all other habitats of the moth; there are but a few imported or planted specimens in the Urban Horticultural Gardens at Giza, Cairo, and a few others now growing in the experimental gardens at Aswan but planted some twenty years later than Miss Jackson's record of *maculifera* from Luxor, where in any case there have never been ash-trees. As for *Amygdalus*, the Almond, the tree is cultivated to some extent in the Mariout and Sinai but further south it is a garden ornamental that dies after ten years and needs replacing; there are a few on this footing at Luxor. It is just possible that a few Syrian examples of the moth were imported with this tree from Syria (though I have only known the Anatolian-Iranian race *pallida* Stgr. to feed on *Amygdalus*); this possibility is very remote, and if a fact the moth would have probably died out later. That it should occur naturally at Luxor is geographically and ecologically impossible, for the requisite ecological conditions do not exist in Egypt: in South-West Asia the moth, I have observed only inhabits plateau-oases at 3000 ft. or higher (e.g. Shtorah in Syria, Isfahan in Persia). In these places it is a univoltine autumnal species flying in x and xi; in Britain the nymotypical race has a similar phenology but inhabits woods and hedges in a cool temperate climate. In the absence of Miss Jackson's specimen certainly is impossible, but perhaps it was the Geometrid *Xenobiston casta* Warren.

As regards the third, *C. ocellaris* Borkh. form *pallego* Hubn., I gave last year what I thought to be the correct identification of this moth, viz. *Eumichtis aurora* (Tur.) *aegyptiaca* Wiltsh.; I might add, however, that now that I realise that the closely related *Eumichtis lea* Stgr. flies also in the Eastern Desert, the possibility also exists that the specimen mentioned in Andres-Seitz (1923) was *lea*; however, since *lea* is less common I still incline to think it was *aurora*. Certainty is impossible without examining the specimen, which Andres found under an *Alhagi* bush at Helwan. It should be recollected that I have found *aurora* commonly at Helwan, and Alfieri has bred it from a pupa found under a *Zygophyllum* bush in the same region.

The true *ocellaris* is Euroriental and monophagous on poplar, which is not a desert tree and in fact does not grow at Helwan nor in Nile valley bordering the Eastern Desert; in the Middle East it is found only in plateau oases (e.g. Syria, the Bekaa (Shtorah); Persia, Isfahan and Shiraz). *C. ocellaris* can therefore certainly be deleted from the Egyptian list.

121. *Bryomima sinaica* spec. nov. (Plate VI, fig. 7).

Comes between *B. codeti* and *luteosordida* Ost.

Forewing, pale rufous more or less heavily infuscated, the basal area least so, the median area most so. Both fasciae are less denticulate than in *codeti nisseni* Roths. (see *Nov. Zool.*, XXVII, 1920, Pl. XV, fig. 24). The antemedian line or fascia is rather indistinct, running at right angles to the costa as far as v.1, where it turns basad, to meet the inner margin obliquely. The postmedian line starts obliquely to the costa, is dentate

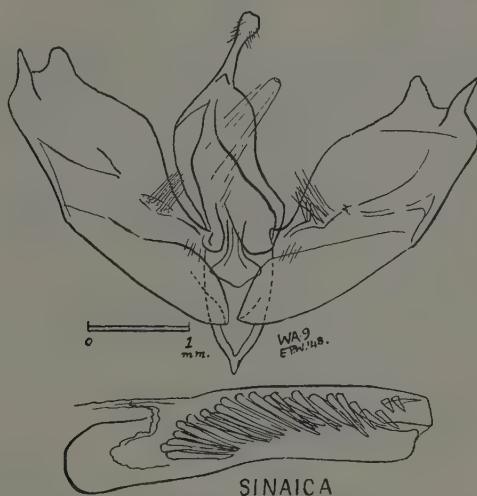


Fig. 24 : *Bryomima sinaica* spec. nov. (♂ genitalia, ventral open view, with aedeagus separated).

where it curves round the cell, approaches nearest to the antemedian line on nervures 2 and 1, where however it is still at least 2 mm. distant, and where the median area is darkest grey. Marginal area, streakily grey-suffused; fringes, paler. Stigmata, whitish, grey-centred, not very clear, the orbicular elongated parallel to costa, the reniform normal. Hindwing, dirty yellow-grey, with paler fringes. Span : 25-26 mm.

The male genitalia (fig. 24) distinguish it decisively from the two relatives named above.

Holo-Type (♂), Gebel Katherine, Wadi el Rabaa, 1500 m., 18-27. iv.40, South Sinai (A.A.). (In coll. Alfieri).

Allo-Type (♀), Wadi Isla, Bir Tarfa, 1430 m., 13-14. iv.40, South Sinai (A.A.). (In coll. Alfieri).

Sub-Family : Zenobiinae (= Caradrinae)

122. *Apopestes spectrum* Esp.

One, 9.v.17, Maadi, near Cairo; one, 10.v.36, Mazarita (Alexandria); one, to light, 1.iii.26, Wadi Ascar, at foot of south scarp of North Galala plateau, Eastern Desert; (A.A.).

The biology and phenology of this Euroriental (?) moth in Egypt are still very obscure. The foodplant is usually a Papilionaceous shrub, e.g. *Spartium* in Syria, *Glycyrrhiza* in Persia.

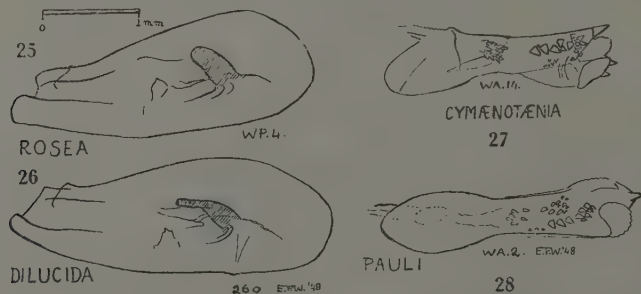
123. *Autophila cerealis* Stgr.

One, 24.iii.20, Rafah, North Sinai; four, 25.v.35, El Kosseima, North Sinai (leg. A. Rabinovitch), (A.A.); one, 28.xii.24, Wadi Watir, Sinai (leg. P.F. Clayton) (A.A.). Also numerous in the mountains of South Sinai in iv (A.A.). Also in the Eastern Desert, rarely.

Probably bivoltine. A desert and steppe moth, ranging from Anatolia and Sinai into Central Asia, i.e. an Eastern Eremic species.

124. *Autophila rosea* Stgr.

Inhabits only the Mariout in Egypt, which is its eastern limit. One male, 25.ii.22, Ikingi (P.); its genitalia are illustrated (fig. 25) together with those of *dilucida* Hubn. (fig. 26), under which name *rosea* was formerly included. The nearest locality for *dilucida* to Egypt is Cyprus. It should



Figs. 25-28 : *Autophila* ♂ genitalia : (25) *rosea* Stgr., (26) *dilucida* Hubner, (27) *cy-maenotaenia orthotaenia* Wilt., (28) *pauli* Boursin. (25 and 26) right valve, interior lateral view, (27 and 28) aedeagus, lateral view.

be noted that the so-called « *dilucida* » from Maadi mentioned in Storey's list was *cerealis* (No. 123).

A purely North African species, inhabiting Mediterranean steppes from the Mariout to Algeria.

125. *Autophila pauli* Boursin (Plate I, fig. 11).

Mitt. Muenchn. Ent. Ges., XXX, h.ii, p. 527, Pl. XI, fig. 79.

Inhabits Sinai and the Eastern Desert. In Sinai it flies in iii, iv and v, and there is one representative of the autumnal brood, an example taken on 28.xii.24 (leg. P.F. Clayton) (A.A.); probably the autumnal brood is out earlier than this. The genitalia are figured together with those of the next species for comparison (figs. 27 and 28). Previously only known from Palestine and Transjordan.

An Eremic species of limited range.

126. *Autophila cymaenotaenia orthotaenia* Wilts. (Plate I, fig. 12).

This species greatly resembles the preceding. In addition to the differences in the genitalia shown, the moth can usually be superficially distinguished by the somewhat rosier forewing with the postmedian fascia more indented below the cell, and also by the narrower pale fascia on the hindwing. The race *orthotaenia*, which ranges from Sinai across Central Arabia into Iraq, is rosier than the typical form from Tunisia and also usually, but not always, has a straighter hindwing fascia. I have only seen one example of this species from Egyptian territory, viz. a male taken together with evidently more numerous *pauli* (No. 125) (25.v.35, El Kosseima, North Sinai, leg. Rabinovitch (A.A.).

Apparently bivoltine, autumnal and vernal; but the two emergences tend to approach one another and it might be one extended emergence of a univoltine species.

An Eremic moth ranging from Tunisia to the Persian Gulf, perhaps further.

127. *Tathorhynchus exsiccatus* Led.

Flies in the Mariout in ii, iv and xii (P.); Maadi, 9.v.17; Mazarita (Alexandria), 10.v.36; Wadi Ascar, Eastern desert, 1.iii.26, 17.xi.23 (A.A.).

Phenology and biology obscure; possibly a migrant.

A very widespread Tropical species.

128. *Amphipyra tetra* F.

One, 18.v.40, 1500 m., Wadi el Rabaa, Gebel Katherine, South Sinai (A.A.).

A Euroriental species.

129. *Euplexia lucipara* L.

One, 14.ix.12, Maadi, near Cairo (A.A.).

A Holarctic species, evidently rare in Egypt.

130. *Trigonophora meticulosa* L.

One, Port-Said, 2.x.13; one, ex pupa, Shubrah (Cairo), garden of Efflatoun Pasha, hatched 2.iii.22 (A.A.). Also recorded by Andres-Seitz (1923) from Ramleh, near Alexandria, at sugar in iii.

Probably bivoltine in Egypt as in Europe. A somewhat migratory Euro-oriental moth.

131. *Sidemia discordans* Boursin (= *discrepans* Stgr. *præoccupata*) (Plate VI, fig. 8, and also 41 I, Seitz III).

Hitherto only known from Palestine, new for Egypt. The one specimen was mixed with a series of *Crino compitalis* Draudt and previously called *Polia peregrina*. The genitalia of this specimen are illustrated (fig. 29).

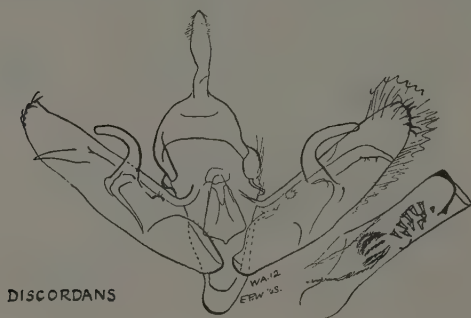


Fig. 29 : *Sidemia discordans* Boursin (♂ genitalia, ventral open view, with aedeagus separated).

Locality: Abu Matamir (Beheira, Delta), hatched 9.vii.14 (A.A.). Very little is known of this moth.

132. *Sidemia beduina* spec. nov. (Plate VI, fig. 9).

Closely related to *discordans* Boursin (No. 131), but, by reason of its foretarsi, linked also with *Pseudamathes* and *Pseudohadena*.

In aspect it is more narrow-winged than *discordans*, and might be taken, perhaps, for a grey form of *Pseudomecia lithoxylea* Bang-Haas. It was actually misidentified by Storey, about thirty years ago, as *Aporophyla australis*, which does not occur in Egypt (but see No. 120 above). Its fore-wing markings and coloration are almost the same as in the Agrotine moth *Agrotis synesia* (Turati) (*Stenosoma synesia* Turati, Plate IV, fig. 1, *Atti Soc. Ital. Sc. Nat.*, LXIII, 1924) but the wing is more elongated, and of course it is not in this genus at all, the male genitalia and fore-tibiae being not Agrotine.

Antenna, plumose; palp, straight, short; eye, smooth, without lashes; tongue, present; frons, smooth; first segment of fore-tarsi with three curved claws outside.

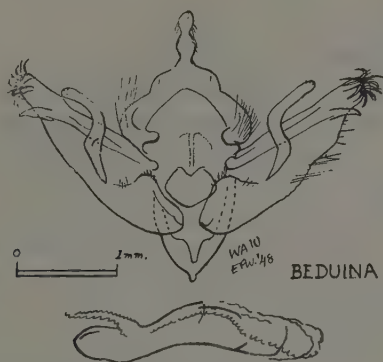


Fig. 30 : *Sidemia beduina* spec. nov. (♂ genitalia, ventral open view, with aedeagus separated).

For the rest see the Plate figure, and the male genitalia (fig. 30).

Holo-Type (♂), 29.xi.19, El Arish, North Sinai (A.A.). (In coll. Alfieri).

133. *Catamecia jordana* Stgr.

Two specimens, 18.vii.17, El Arish (North-East Sinai).

Previously only known from Palestine.

134. *Scythocentropus inquinata* Mab. (= *ferrantei* Draudt).

Common in deserts both East and West of the Nile, also in Sinai, flying in x, xi, and xii; reported from Benha (Delta) by Herzog (see Andres-Seitz, 1923).

The biology of this univoltine autumnal moth is unknown.

An Eremic species, ranging from Morocco to South Persia.

135. *Bryophila pallida* B.-B.

Described as a form of *fraudatricula*, later considered a variety of *strigula* Borkh., and also recorded as *algac* F., this little moth was only recognised as a good species, but widespread in the Mediterranean, recently, as a result of the article by Boursin, 1940, *Bull. Soc. Linn. Lyon*, Nos. 7-10 (9th year), where the genitalia were illustrated. So far no other member of this group has been recognised from genitalia-studies of Egyptian specimens.

Flies in the Mariout and Alexandria regions in ix, x, perhaps also in v; at least it has been reared from the larva in v.

The larvae were found on lichens of fig-tree branches; doubtless other kinds of tree also carry its foodplant.

A Mediterranean species.

136. *Bryophila muralis amasina* Stgr.

(Plate 2g, Seitz III, Suppt.).

As pointed out last year, the record of *perla* from the Alexandria vicinity is to be deleted. The species in question is indubitably a pale form of *muralis*, as should have been apparent to previous writers from the facies even without consulting the genitalia. It flies in the Mariout and around Alexandria in viii and ix. It feeds on lichens, on walls and trees.

This mistake seems to have seriously misled no other than the great zoogeographer Rebel, who accepting, as many zoogeographers are apt to accept, the existing literary records, dismissed, as recently as 1938, the possibility of the occurrence in Crete of *B. muralis*, in these words: « Warnecke has published a list of 26 species from Crete, of which 11 are new for the island... No. 6: *B. muralis* Forst. From my experience of the Eastern Mediterranean... I would divide these eleven species into two groups; those whose occurrence in Crete is out of the question, and those whose occurrence there at least requires further confirmation.... In the second group comes*muralis*....*B. muralis* can hardly occur in the Eastern Mediterranean. It is absent too from Cyprus... » (*Iris*, 52, 1938, p. 34). Thus Rebel's ignorance of the occurrence of *muralis* commonly in the Lebanon and his uncritical acceptance of previous Egyptian lists leads him quite without reason to strike out Warnecke's record of *muralis* from Crete; its occurrence there, with that of some others which Rebel doubted, seems to me quite probable. This is just another example of the need to build zoogeographical speculations on a foundation that is taxonomically flawless.

B. muralis is a Mediterranean as well as a European moth, being known, not only from Egypt, the Lebanon and Turkey, but also (according to Zerny, 1935) from Morocco.

137. *Bryophila* ? *paulina* Stgr. (Plate VI, fig. 10).

This species has been recorded both as *paulina* and as *maconis* Led., the latter determination is wrong, the former not quite certain yet. It resembles the species figured as *paulina* Stgr. in Seitz, Suppt. III, Pl. 21. What makes this doubtful however is that the genitalia are not the same as those of *Bryophila keltana* (Ams.) which is said to be a synonym of *paulina*. The genitalia of the Egyptian moth are illustrated herewith (fig. 31) in the hope that this will help to clear up the question sooner or later.

Flies in the Eastern desert in two broods, the first in ii, iii and iv,

the second in viii. The only lichens I have observed in this region grow on stones on hill-tops and these are probably its foodplant.

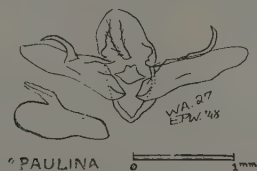


Fig. 31 : *Bryophila (p) paulina* Stgr. (♂ genitalia, ventral open view, with aedeagus separated).

138. *Bryoleuca trilinea* B.-Baker.

Flies in the Alexandria vicinity and the Mariout in viii and ix. According to Andres-Seitz (1923) the larvae feeds on wall lichens in v.

The species in its form *syrticola* Turati is also an inhabitant of other parts of the Eastern Mediterranean coast, and reaches the Moroccan Sahara.

139. *Arsilonche albovenosa centripuncta* H.-S.

One, bred from a larva on *Phragmites*, Farascour (Dakahlieh), which spun its cocoon on 6.vii.26 and hatched 17.vii.26 (A.A.). There is also a larva-skin with similar data. The example, a female, was determined as above by Mr. W.H.T. Tams of the British Museum. Not hitherto recorded from Egypt.

A bi-voltine Euroriental species.

140. *Prodenia litura* F. (= *littoralis* Janisch, etc.).

Especially in the cultivation of the Nile valley and delta, but also occasionally in the desert, e.g. one from Hurgada (Red Sea coast), viii. 1935 (A.A.), though possibly this locality also has oasis vegetation. It also inhabits the Mariout. It is multivoltine, polyphagous, and a serious pest on cotton and many other crops.

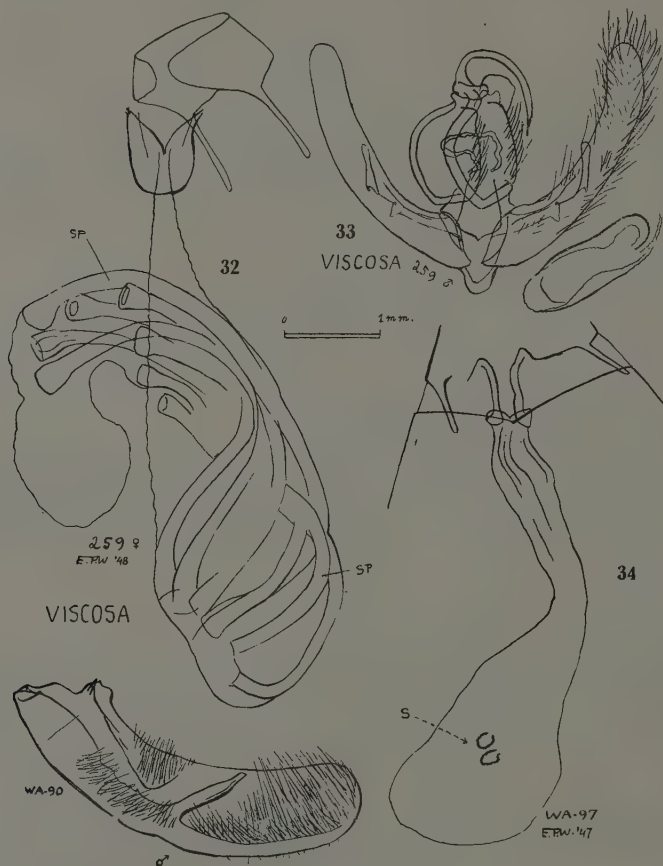
For details see F.C. Willcocks : 1905, and 1922; and Willcocks and Bahgat, 1937, with a fine coloured plate of its life-history (Pl. XI). Also Dr. E. Janisch, 1932 « The influence of temperature on the life-history of insects », which details experiments on this species made in Egypt (*Trans. R. Ent. Soc.*, London, LXXX, Part ii).

A Tropical widespread pest, probably migratory.

141. *Hadjina viscosa* Freyer.

Very variable according to habitat and season. This species has been confused with the next, which is much rarer and less widespread; its genitalia are therefore shown (figs. 32 and 33). The Egyptian material I have

seen is as follows: one ♂, 15.x.26, Giza (Cairo), and one ♀, 25.ix.23, Deirout (Beheira) (both A.A.). The so-called *viscosa* in coll. Petroff were in fact *coptica* (No. 143a below).



Figs. 32-35: Both sexes genitalia of (32 and 33) *Hadjina viscosa* Freyer, and (34 and 35) *Propsalta coptica* spec. nov. (see Addendum). (32) impregnated ♀, SP = spermatophores in bursa; (34) virgin ♀, without spermatophores, S = two signa (both, ventral view); (33) ♂ genitalia, ventral open view, with aedeagus separated; (35) right valve of male, interior lateral view.

Its foodplant in Egypt is chiefly *Pluchea dioscoridis*, which is fairly common along canals and river banks in the Nile valley and Delta. It is definitely an oasis not a desert moth.

A widespread Mediterranean species, ranging from the Canaries to South Persia and Oman. In typically Mediterranean districts its foodplant is *Inula viscosa* (e.g. Lebanon, Cyprus), but in more Eremic parts (e.g. Cairo, Basra) *Pluchea* is the main foodplant, a genus also known as *Conyza*.

142. *Hadjina palaestinensis* Stgr.

This species is much rarer. It has been confused with the preceding and the records of Brandt from South Persia are in fact *viscosa persicola*

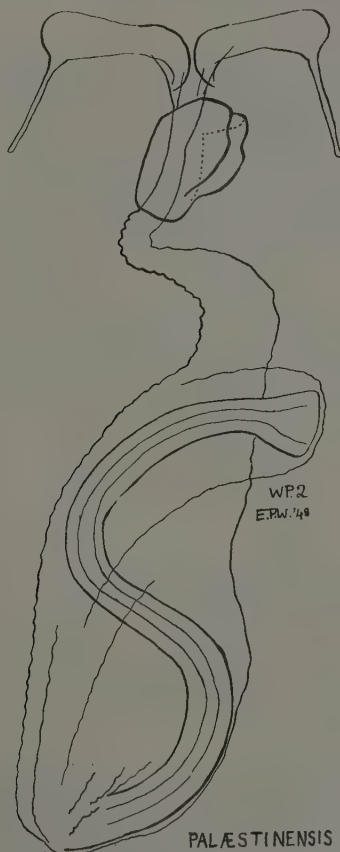


Fig. 36 : *Hadjina palaestinensis* Stgr. (♀ genitalia, impregnated, with one spermatophore, in bursa).

Strand, as I ascertained from the genitalia of specimens kindly sent by Brandt himself. I have not yet seen a male of this rarer species nor compared the genitalia of the female with those of Staudinger's type; the

possibility remains that the type is no more than a dark and large *viscosa* form, in which case a new name will have to be found for the present species. It has also been confused with the following species. The female genitalia are illustrated (fig. 36). The Egyptian material seen is as follows: One female, Alexandria, date uncertain (P.).

An East Mediterranean species, only known from Egypt and Palestine.

143. *Propsalta capensis* Guen.

In my view true *capensis* Guen. is only found in Upper Egypt, and *capensis* Andres-Seitz (1923) is distinct (see Addendum).

143a. *Propsalta spec. nov.* (see Addendum).

Inhabits the Delta, and the Alexandria and Cairo districts, flying in xi, xii and iii (and probably in other months too).

The genitalia are illustrated (figs. 34 and 35) since the moth has been confused with Nos 141 and 142; the ♂ valva, and the two signa on the ♀ bursa at once distinguish it, but there should really be no need to dissect it.

The larva has been found eating *Pluchea dioscoridis*, and also once reported (at Giza) on Cinerarias (presumably *Senecio cineraria*). In food-plant therefore it resembles the two previous species (141, 142) specialising on Compositae, as far as is known.

The larva was described in Andres-Seitz (1923).

Apparently an Endemic moth, and only found in Egypt on oasis biotopes.

144. *Spodoptera latebrosa* Led.

There are specimens taken in iii, iv, v, vii, ix, x, and xi from the Cairo vicinity, the Mokattam hills, the Mariout, and Alexandria. It probably only breeds on oasis biotopes and is there multivoltine.

An Old-World Tropical and Sub-Tropical moth of wide range. Probably conspecific with *S. cilium* Guen.

145. *Laphygma exigua* Hubn.

Can be distinguished from the preceeding, not only by the generic differences mentioned in Seitz III and the male genitalia, but also by the two forewing stigmata; in *exigua* the orbicular is yellow with a red-brown centre; in *latebrosa* the reniform has a blackish centre.

All the year round, multivoltine but especially numerous in the North in v.

A well-known migratory pest, for details of which see F.C. Willcocks and Bahgat, 1937, with a coloured plate of its life-history (Pl. X).

It invades the deserts of the Sub-Tropics during the mild winter and

and concentrates in the oases in the summer. It is widespread in the Tropics and Sub-Tropics.

146. *Hoplodrina ambigua* Schiff.

According to Andres--Seitz (1923) this is widespread and fairly common in Lower Egypt. It is therefore strange that there is no example of it in the material at my disposal. Nevertheless, this particular species is easier to recognise than some other *Caradrina* and neighbouring species, so I accept the record.

Apparently multivoltine; Euroriental.

147. *Caradrina* (subg. *Hymenodrina*) *aspersa* Ramb. (Plate VI, fig. 11).

This genus has been also known both as *Athetis* and *Elaphria* recently but can now be called *Caradrina*. The remarks of Seitz in Andres-Seitz (1923) are misleading, for he generalises from exceptional cases. I do not think that any member of this genus in Egypt is independent of vegetation, and the fact that Seitz has found one species of *Caradrina* larva eating wine-corks should not induce Egyptian lepidopterists to look in wine-shops for *Caradrina* caterpillars! The larvae are all, as far as I know, polyphagous on low plants and perhaps trees and shrubs too.

The first species (*aspersa*) is rather rare. Petroff claims to have found it in Alexandria but the example is missing. Two females, xi, Cairo (E.P.W.). One of these however is distinct (see Addendum).

Euroriental.

148. *Caradrina* (subg. *Hymenodrina*) *oberthuri persica* Boursin.

Common in the mountains of South Sinai in iv (A.A.).

A bivoltine species, although the autumnal brood has not yet been taken in Egypt. It is an Eremic moth, ranging from Algeria to South Persia.

149. *Caradrina* (subg. *Paradrina*) *mairei* Draudt.

A coloured illustration appeared in Andres-Seitz (1923) of this form which is now considered a separate species from *selini* B. Reported, in the same work, as occurring rather rarely in the Mariout in spring; perhaps there is also an autumnal brood. The species seems at present only known from North Africa.

150. *Caradrina* (subg. *Paradrina*) *clavipalpis mauretanica* Draudt.

From Alexandria and Mariout, x and xi (P.). One ♀ (27.x.47, Cairo, E.P.W.).

A bivoltine Euroriental species able to inhabit steppes but not usually real deserts.

151. *Caradrina* (subg. *Paradrina*) *atriluna* Guen. (= *angularis* Tur., = *mediterranea* B.-B.).

All the year round in the Cairo neighbourhood (A.A. and E.P.W.). Also reported from Sinai by Kneucker (Rebel, 1909). It also inhabits the Alexandria vicinity, whence Bethune-Baker's type came. As his name implies, the moth's range is Mediterranean but not narrowly, for it reaches South-West Persia, and has been recorded by Berio from Eritrea (Tropical Africa).

152. *Caradrina* (subg. *Paradrina*) *katherina* Wilts.,

(*Bull. Soc. Fouad 1^{er} Entom.*, XXXI, 1947, p. 4, fig. 1 (genitalia) and Plate Figs. 2 and 3).

There is little to add to my original description published last year. Possibly it exaggerated the iridescence of the hindwings, which is less strong than in *exigua*, though greater than in *clavipalpis*. There is probably also an autumnal brood, but the phenology is unknown. It is also not known whether the species is really endemic to South Sinai as appears at present or whether, perhaps, it also inhabits Arabia Petraea.

153. *Caradrina* (subg. *Paradrina*) *flava* Ob.

One male, 25.iii.24, Mahatta Maskhara (Eastern Desert), which had previously been determined as « *Autophila dilucida* var. *rosea* Stgr. » (see No. 124 above).

A bivoltine Eremic species, ranging from Morocco to South Persia. Its dull orange colour makes it easily recognised, among its congeners.

154. *Caradrina* (subg. *Eremodrina*) *melanurina* Stgr.

Inhabits the Eastern Desert and probably Sinai too. Has been taken in x and xi, but there is also a spring brood, at least when bred.

Since the early stages have not been described, I give hereunder my own notes on the life-cycle, observed when I reared the species from eggs laid on 2.xi.47 by a female caught in the desert at Helwan on 1.xi.47.

The egg is bun-shaped, with faint fine apically-convergent sculpture, grey-white at first, later ochreous with vague pale brown ring developing. A black disc-like spot appeared later and proved to be the head of the young larva. The first larvae hatched on 15.xi; in captivity they fed up quickly and had all buried and spun up by mid-i.48.

The freshly hatched larva is grey-white with black head, thoracic and anal plates, and setae; the feet are also marked with black laterally. Those eating grass turned green. Later the glossy black markings progressively disappeared and the larva was a thinly pigmented inconspicuous creature. In the second instar, it was greenish brown, with whitish dorsal and subdorsal stripes, the setae alone being still glossy black. When full-

grown the spiracles were still black, but not the setae, or head; the markings were now weak, consisting of a faint mottled dorsal chain of lozenges, paler centred; the head was glossy brown, small, inconspicuous.

Foodplants: Almost any low plant or grass offered was eaten; the larvae were reared on a mixed diet of sliced carrot, cooked peas, sweet pea flowers, chrysanthemum petals, grass, and various low plants' leaves.

Some of these larvae hatched as adults in iii.48, others, at the time of writing, were apparently aestivating as pupae. The adults that hatched were crippled, perhaps owing to faulty diet.

An Eremic species only known at present from Palestine and the Eastern Desert of Egypt.

155. *Caradrina alfierii* Boursin.

Ent. Rundsch., 54, 1937.

Described from a single female, 22.xi.26, Um Arad, Sinai (leg. Kaiser) (A.A.), this Eremic species has been retaken, again only in the female sex in South Persia. Its subgenus is still uncertain. It has a wider black border than *melanurina* (No. 154) and seems scarcer, at least in Egypt. It was illustrated in Seitz III Suppt. (Pl. 26 k.). Captor and locality are wrongly cited in the original description.

156. *Namangana* (? *Pseudathetic*) *fixseni* Christ.

Flies in the Eastern Desert in iii, iv and again in autumn, but seems rather scarce; there are but three specimens in coll. Alfieri.

An Eremic species ranging eastwards to West Turkestan.

157. *Pseudamathes volloni* Lucas (Plate I, fig. 13).

New to Egypt. One female, 13.xi.47, Helwan desert, (F.P.W.).

Phenology uncertain; a North African Eremic moth.

158. *Eriopus latreillei* Dup.

One, 28.xii.14, near Alexandria; one, 21.viii.19, Cairo (A.A.).

Multivoltine, Euroriental.

159. *Sesamia cretica* Led.

Everywhere in the Nile valley and delta. A very pale and rather small female, identified by its genitalia, 23.iii.24, South-East Sinai (A.A.), probably from an oasis under strong eremic influence. Probably also inhabits coastal dunes; at least on the Lebanese coast it does so, its foodplant there being *Saccharum aegyptiacum*, a common and beautiful reed found in various habitats in Egypt (Arabic name Bus.), including the dunes. There are larval skins and moths reared from larvae found on maize and other cereals (A.A.). It can be quite harmful as a boring pest on these. Its wild foodplant being so prevalent, it will be hard to eradicate this moth

by attention to crops. At Aswan, Hayward took it fairly commonly from ii to vi. It appears to be bi-voltine, flying in early summer and again in autumn; the second brood seems scarcer.

Pending a taxonomic revision of the *Sesamia* species of the world, I prefer to reserve judgement on the record of *Sesamia uniformis* Dudg. in Andres-Seitz (1923) from Egypt. It should be recalled that these writers did not examine the genitalia of their specimens before confidently bursting into print, so their records are not quite reliable in difficult groups or genera. For the same reason it is not yet safe to give the total range of *S. cretica*. Rocci and Turati have published a partial revision of some Mediterranean Wainscot Moths (*Mem. Soc. Ent. Italiana*, XII, XIII, 1933-34) where the genitalia of *vuteria* and *cretica* were illustrated. From this it appears that *cretica* can be distinguished without dissection in the male sex by the antennae which are ciliated while those of *vuteria* are bipectinated; differences in the larval coloration are also given. The same authors conclude that the Cyrenaican so-called *calamistis* are in fact *vuteria* Stoll.

160. *Sesamia vuteria* Stoll. (= *nonagrioides* Lef.).

Easily distinguished from the preceding species by its thickly pectinated male antennae; one, 7.x.17, Alexandria (P.).

Its habits are similar to those of No. 157, its economic importance where it occurs, is similar. There is similarly a doubt regarding its world-range.

(*Nonagria maritima* Tausch. was recorded by Hayward as common from iii to xi at Aswan. It is a North European marsh moth, and the record has not been confirmed by any other captures. Moths of the reed-swamp ecofauna are seldom migrants on a small scale and never long-range migrants of the class of *Celerio lineata livornica* or *Vanessa cardui* (Nos. 70 and 6 above). Nor indeed does Hayward's record suggest an immigrant, for northerly immigrants only visit the torrid sub-Tropics in winter as a rule. If any moth of this ecofauna inhabited Egypt the most likely points for it to be found would be the marshes of the northern Delta, five degrees of latitude further north, and in fact two species of the ecofauna occur in the north, e.g. No. 139 above, and No. 161 below. Neither is found south of Cairo, if as far as that. No other member of this ecofauna has been recorded from Egypt at all, apart from this record of Hayward's, and this is not surprising when we consider the arid nature of the North African and South-west Asian coasts and the fact that the Nile runs from south to north and reaches the Mediterranean Sea at lat. 31-32 N.; the vegetation along its banks is preponderantly Tropical or Eremic and the insect fauna thereof shows a similar derivation in the main. Certain northern species undoubtedly occur as far south as Aswan, but these few are common throughout the Nile valley and without exception migratory (e.g. *P. rapae* L., No. 31), and usually also commoner in the North than at Aswan, which is close to the Tropic.

Outside Egypt, in Sub-Tropical latitudes and Eremic or at least arid territories, the reed-swamp ecofauna penetrates furthest southwards at heights of several thousand feet (e.g. Iran), and also, to a lesser extent along southwards-flowing rivers (e.g. the Tigris).

What makes Hayward's record all the stranger is the phenology of *maritima*, which is univoltine; yet Hayward's moth is clearly a multivoltine species. Other lepidopterous mem-

bers of the reed-swamp ecofauna penetrating Sub-Tropical climes are, like *maritima*, univoltine, but do not increase the number of broods despite the warmer climate (see Wiltshire, 1941: "The summer flight in cold climates of vernal and autumnal lepidoptera", *Ent. Rec.*, 73). By analogy *maritima* if indeed it anywhere penetrated southwards would remain single-brooded, merely emerging earlier in the year than further north.

Without seeing the specimens one can only guess what the correct identity of the moth Hayward thought *maritima* may be. My own opinion is that it was probably the Pyralid *Lamoria anella* Schiff. or *jordanis* Rag., both reported from the Nile valley by Rebel, and neither recorded by Hayward among his Pyralids. In any case I am convinced *N. maritima* should be deleted for the reasons given above).

161. *Phragmitiphila typhae* Thunb.

One, Sidi Bishr (East Alexandria), 29.vi.22 (A.A.).

A univoltine reedswamp moth, emerging in the autumn further North. It is Euroriental and occurs in South Persia at 9000 feet (see the remarks above on *N. maritima*).

Foodplant: *Typha*.

162. *Acosmetia arida* Joann.

There is nothing new to say about this name no new material having been taken. See Seitz III and Andres-Seitz, 1923. Apparently a rare endemic desert moth.

163. *Synthymia solituda* Brandt.

Ent. Rundsch., 1938.

Four, iv.40, various localities in the mountains of South Sinai (A.A.).

An Eremic species hitherto only known from a low altitude (desert mountains) in South-West and South-East Persia. Apparently univoltine vernal.

164. *Aegle vespertalis petroffi* Andres-Seitz (1925).

Of two mentioned in Petroff's catalogue (in litt.) as taken on 25.iii.22 and 19.vi.20 at Ikingi-Mariout, only one remains, presumably a para-type though not marked or dated.

Typical *vespertalis* Hubn. is known from Cyrenaica and Tripolitania and it is not yet clear whether this form is simply an aberration or possibly a local race.

A Mediterranean species, apparently bivoltine.

Sub-Family: Melicleptriinae

165. *Chloridea peltigera* Schiff.

Observed all the year round at Aswan by Hayward; evidently common in iii, iv, and v, especially the last month, in the Eastern Desert and Sinai (A.A.). Flies in spring and summer at Alexandria and in the Mariout (A.A., P.). The pale yellow form is a reaction to heat and drought, the darker, richer-coloured forms occur principally in early spring and in oases.

Various foodplants are given in Andres-Seitz (1923). It is polyphagous especially favouring the flowers of herbs. It is a migratory multivoltine moth, inhabiting the Mediterranean basin, and extending eastwards to Persia and southwards across the Tropic into Eritrea.

166. *Chloridea obsoleta* F. (= *Heliothis armigera* Hubn.).

All the year round, in oases of Lower Egypt.

Illustrated in colour in Plate XIII in Willcocks and Bahgat. 1937, with an account of its life-history.

A Holo-Tropical pest and migrant, especially harmful to cotton in America.

167. *Chloridea nubigera* H.-S.

Hayward observed this moth from iv to vi and occasionally in autumn at Aswan, but did not find it common. In Upper Egypt its phenology is similar but it seems common from iii to v; these records are, however, mostly desert records while the Aswan records probably represent an oasis population.

Two examples from Sinai, 22.xi.26, Um Arad (leg. Kaiser) and Abu Zeneima, 29.v.35 (leg. Rabinovitch), (A.A.). One from Siwa Oasis, ii.28 (A.A.).

The species is doubtless migratory. Its habits and range are very like those of *peltigera* (No. 165). In the Eastern Desert and also at Giza its desert foodplant is *Zygophyllum album* and *coccineum*, on which it is found sometimes in numbers in ii (E.P.W.) and iv (A.A.).

168. *Melicleptria scutosa* Schiff.

Three, El Arish (North Sinai), 23.ii.22, and two on 9.v.17 (A.A.) Perhaps not really resident here.

A Euro-Siberian migratory species, multivoltine.

Group II : Quadrifinae

This group badly needs revising, and it has unfortunately proved impossible to find a specialist on it to consult. It is clear that the traditional Hampsonian Sub-Families have been erected on the basis of a minor character (tibial spines); in particular the separation of *Catocalinae* from *Noctuinae* on this ground is unsound. These two are combined into one sub-family, the *Catocalinae*, by McDunnough for the New World, and this should be done for the Old World. Some formerly « Noctuid » genera will then have to be brought into the neighbourhood of *Catocalinae* genera from which they are at present far separated. In what follows I have only made a change of this sort where my own studies have proved it necessary (e.g. the bringing together of the genera *Leucanitis* and *Syneda* (= *Aleuca-*

nitis) : see figs. 59 and 60, and Plate I, figs. 14 and 15) ; elsewhere I have been obliged to follow the traditional but partly erroneous order of genera given in Seitz.

Sub-Family : Erastrinae

169. *Leptosia velox* Hubn.

One, 8.vii.18, Ikingi-Mariout (P.) ; one, 20.viii.14, Fleming (Alexandria) (A.A.).

New for Egypt. A Mediterranean moth.

170. *Leptosia* (?) *griseimargo* Warren.

One, iii or iv.28, Gebel Elba ; rather larger and less well-marked than the figure in Seitz III. Warren's type was from Algeria. Also new for Egypt.

171. *Coccidiphaga scitula* Ramb.

Hatched from larvae feeding on *Lecanium hesperidum* on mandarin trees, Zagazig, 12.xi.26 ; hatched from scale-insects on tamarisk, Gezireh (Cairo), 29.x.17 ; hatched from larvae on *Ceroplastes africanus* on tamarisk at Roda (Cairo), 29.viii.17 ; hatched from larvae feeding on Coccid *Lecanium elongatum* on vine-leaves ; (two) Mit Gamr (Delta), 10.x.26 ; (A.A.). Also five from Bulkeley (Alexandria), in v, vii and ix. Also at Aswan, where Hayward took it.

Beneficial to agriculture and horticulture ; multivoltine ; widespread in Tropics and Sub-Tropics of the Old World.

172. *Coccidiphaga spirogramma* Rebel.

Two, 15.x.24, and 15.x.16, Maadi (A.A.).

An apparently endemic species only known from the Mokattam desert country and Eastern Desert.

173. *Porphyrinia ostrina* Hubn.

Inhabits the Mariout, the desert on both sides of the Nile valley near Cairo, and the whole North Coast of Egypt ; it also occurs, more rarely in the extreme south (Aswan), but perhaps is not a desert moth there. One of A.A.'s specimens was bred from *Echinops spinosus* from the desert near the Giza Pyramids.

A multivoltine Eurooriental species.

174. *Porphyrinia parva* Hubn.

Has been bred by A.A. from larvae of *Inula crithmoides* at Farascour and *Centaurea pallescens* from the Suez Road (Eastern Desert). Other material is from the Alexandria district, the Mariout, the Delta, etc., and Hayward reported it as common at Aswan.

A multivoltine very widespread species.

175. *Porphyrinia cochylioides* Guen.

The pale form *calida* Rebel is evidently not seasonal in this species any more than *f. aestiva* is in *ostrina* (No. 173); it may however still be due to more arid conditions affecting individuals; perhaps however it is inherited. Flies in vi, ix, x, and xii in the Cairo and Alexandria neighbourhoods (A.A.), apparently an oasis moth.

Widespread in the Old World Tropics.

176. *Porphyrinia nives* Brandt.

Ent. Rundsch., 1938.

One, 23.iii.27, Wadi Ascar; one, 30.iv.25, Wadi Gharba (both Eastern desert); A.A. Previously only known from South Persia.

New for Egypt.

That there is some faunistic affinity between the desert mountainous country of Southern Sinai and the Egyptian Eastern desert on the one hand and of South Persia on the other appears from this discovery, and also that of the species *C. alfieri* (No. 155) and *S. solitudo* (No. 163) above, and *A. arenosa* (No. 231) below, and also the parallel discovery by Mr. Joseph Shabetai of the Persian tulip *T. polychroma* in the Southern Galala (western branch of Wadi Ascar). I have seen this delicate tulip in the same sort of terrain that I have taken *P. nives* on in Fars, South-West Persia, though the altitude there is very much higher than the highest point of the Galala plateau. The moth was retaken by Fred Brandt in Persian Baluchistan at a somewhat lower elevation however.

177. *Porphyrinia deserti* Roths.

Four, iv.1940, mountains of South Sinai (A.A.).

A North-African Eremic species.

Andres-Seitz (1925) recorded for Egypt, on the basis of the original description by Rothschild from Shendi, *Porphyrinia wollastoni* Roths.. They were evidently under a misapprehension as to the location of this town, for they erroneously stated it to be in Upper Egypt. In fact it is on the Nile between Atbara and Khartoum, about lat. 16.40 N. The moth has never yet been taken in Egypt and must be deleted.

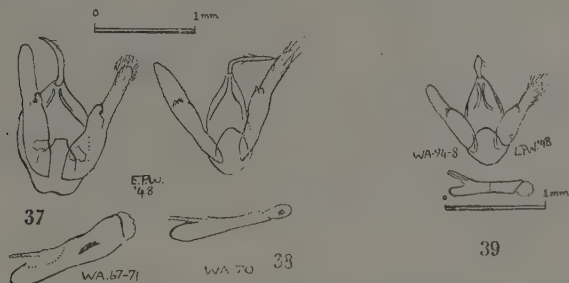
Storey (1916) recorded from Alexandria, in vii, *Porphyrinia suppura* Sigr., a Mediterranean moth, whose occurrence in Lower Egypt seems not improbable; Andres-Seitz (1923) apparently regarded this species as conspecific with *albivestalis* Hamps., which they recorded from Heliopolis desert and Bercash in iv and ix. I have myself not seen any examples from Egypt of *suppura* and the examples in the Cairo collections labelled *albivestalis* Hamps., are in my view another species. The occurrence therefore of these one (or two species) in Egypt requires further confirmation, though I do not assert that they must be deleted.

178. *Porphyrinia* (?) *virginalis* Ob.

The series in coll. A.A. identified as *albivestalis* Hamps. (see Andres-Seitz, 1923) seems to me to fit better the description of *virginalis*; this tentative identification is made more probable by the presence, in the series,

of specimens with identical genitalia (see fig. 37) but a streaked, browner forewing, which may be ab. *caid* Ob. The whiter specimen is from Bahariya Oasis, 22.iii.25; the browner slightly streaked form is from Minieh (Upper Egypt, Nile valley), 24.ix.14.

A North African Eremic species.



Figs. 37-39 : Three *Porphyria* spec. (♂ genitalia, ventral open view, with aedeagus separated). (37) *Porphyria* (?) *virginalis* Ob., (38) species near *uniformis* Stgr. (see text). (39) *Porphyria tomentalis* Rebel (see Addendum).

179-180. *Porphyria* spp.

There are two species mixed with the foregoing species in the local collections and appearing, in part, under the name *uniformis* Stgr. (see Andres-Seitz, 1923). According to the genitalia there are three distinct species. Of these No. 180 stands apart by reason of its much smaller genitalia, club-shaped uncus and aedeagus without cornuti (fig. 39). Nos. 178 and 179 have more slender hooked unci and differ from one another chiefly in the amount of cornuti in the aedeagus (see figs. 37-39 for the tail-parts of the three).

No. 179 is represented by a single specimen from Beni Mazar (Upper Egypt, South of Beni Suef), 29.v.16 (A.A.) (fig. 38).

No. 180 is very widespread : there are examples labelled : 18.ix.23, Wadi Tih; 6.xi.13, Heliopolis; 21.vi.36, Suez Road; and two, iii-iv.28, Gebel Elba; (A.A.). I presume this to be the species called *uniformis* Stgr. in Andres-Seitz (1923). It agrees fairly well with the plate of *uniformis* in Seitz III, less well with the text.

181. *Porphyria himminghofeni* Mill.

Five, 1.viii.32, Suez Road; four, 22.vii.22, on grasses, Suez Road (Eastern Desert); (A.A.).

A Mediterranean species.

182. *Autoba gayneri* Roths.

Throughout the Nile valley, from Aswan to the Cairo vicinity; not yet recorded from the Delta or North Coast. The form *beraudi* Joannis belongs here, and is the commoner of the two in the Cairo district.

The larva feeds on the flowers of numerous trees, e.g. *Acacia nilotica* (E.P.W.), *Eriobotega* (*Photinia*) *japonica*, *Zizyphus*, etc., and also on coccids on tamarisks, and *Phenococcus hirsutus* on *Hibiscus* (A.A.). It is multivoltine.

Has also been recorded (by Krüger 1939) from Tripolitania.

183. *Autoba teilhardi* Joannis.

One, 6.vii.29, Heliopolis, leg. Andres (A.A.). One, bred from larvae taken with those of the previous species on *Acacia nilotica* flowers at Maadi (E.P.W.). Recorded on fig from Upper Egypt by Storey.

Apparently endemic to Egypt.

184. *Ozarba variabilis* Berio.

Mem. Soc. Ent. Ital., XIX, 1940, p. 188.

Four, Gebel Elba, iii-iv.28 (A.A.). These examples were sent to Rebel and designated types of *elephina* Rebel, a synonym (May 1948). Berio described the species from Eritrea, and the Egyptian specimen's genitalia agree with his plate.

185. *Ozarba timida* Berio.

Mem. Soc. Ent. Ital., XIX, 1940, p. 184.

Two, Gebel Elba, iii-iv.28 (A.A.). These specimens were sent to Rebel and designated types of *cervina* Rebel, a synonym (May 1948). Berio described the species from Eritrea, and the Egyptian species' genitalia agree with his plate.

These two species (Nos. 184 and 185) are doubtless members of the Eritrean Tropical fauna which only penetrate Egypt in the extreme South-East, cf. Nos. 2, 4, etc.

186. *Xanthoptera mesozona* Hamps. (= *Eulocastra mediana* Stgr.).

One, 2.xii.25, Wadi Um Kibsh, near Hurgada, Eastern Desert (A.A.). The male genitalia are shewn (fig. 41).

An Eremic species, occurring in deserts north and south of the Tropic in North-East Africa and South-West Asia.

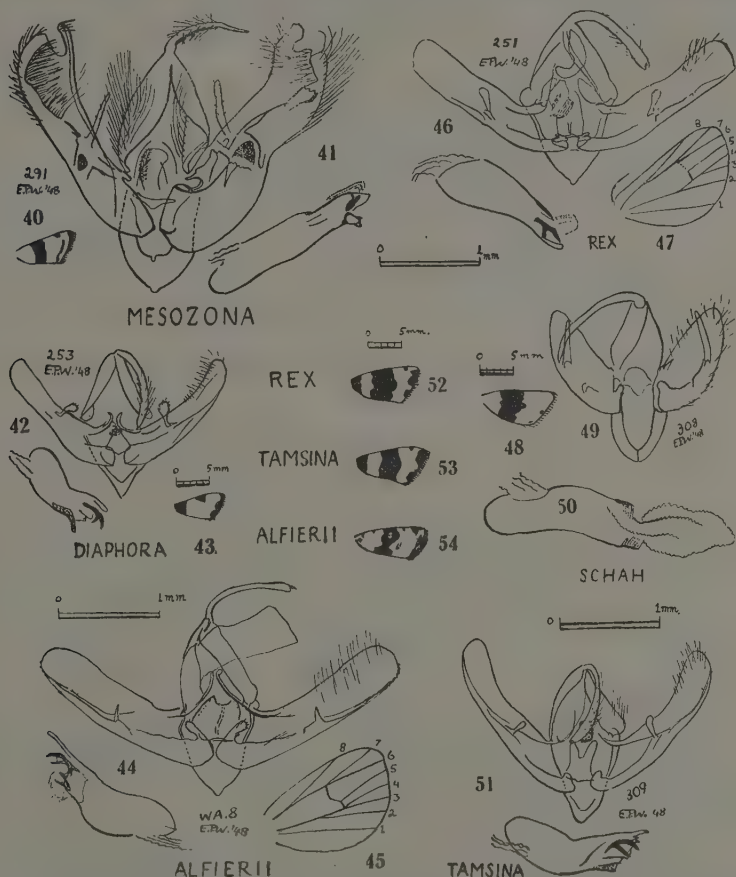
187. *Thalerastria diaphora* Stgr.

A good series, all in iii and iv, from the Eastern Desert and South Sinai (A.A.). One, 19.vi.20, Ikingi-Mariout (P.). The genitalia are shown (fig. 42).

An Eremic species ranging from Western Morocco to Armenia and North India.

188. *Thalerastria alferii* spec. nov. (Plate VI, fig. 12).

I attribute this new species to this genus with reserve pending a thorough revision of the world species of *Thalerastria*, *Eulocastra*, *Xanthop-*



Figs. 40-54 : To illustrate the specific differences and generic relationship of certain *Eulocastra*, *Thalerastria*, and *Xanthoptera* species : (40 and 41) *Xanthoptera mesozona* Hamp., (42 and 43) *Thalerastria diaphora* Stgr., (44, 45, and 54) *Thalerastria alferii* spec. nov., (46, 47, and 52) *Thalerastria rex* spec. nov. (South West Arabia), (48, 49, and 50) *Eulocastra schah* Salz and Brandt (Persia), (51 and 53) *Eulocastra tamsina* Brandt (Persia). (40, 43, 48, 52, 53, and 54) forewings; (41, 42, 44, 46, 49, 50, and 51) ♀ genitalia, ventral open view, with aedeagus separated; (45 and 47) hindwing neuration (schematic).

tera, etc.. The present species is congeneric with the genotype of *Thalerastria* (No. 187), as the male genitalia show (see fig. 44), but also with certain species described as *Eulocastra* (e.g. *E. tamsina* Brandt from South-

East Persia, whose genitalia are also illustrated, fig. 51). The genitalia differ notably from those of *mesozona* Hamps. (No. 186 above) and *Eulocastra schah* B.-Salz and Brandt, whose genitalia I also shew (figs. 49 and 50). These two latter species, though agreeing well enough in head and wings must, according to the genitalia, each be placed in a separate group (? genus, ? sub-genus).

The new species *alfierii* has hindwing veins 3 and 4 connate (fig. 45).

Forewing, dirty white, with powdery-grey central band constricted on nervure 2, and other markings consisting of a basal patch sometimes obsolete, a sub-apical spot on the costa from which an irregular and incomplete submarginal line proceeds and runs along the termen towards the tornus, and sometimes other shades. Hindwing, dirty white in the male, grey in the female. Span : 22-25 mm.

Holo-Type (♂) : 6-9.iv.40, Bir Isla, 390 m., South Sinai (leg. A.A., in coll. Alfieri).

Allo- and Para-Types (♀ ♀) : 10-12.iv.40, Wadi Isla, Karm Alam, South Sinai (leg. A.A., in coll. Alfieri).

I append here the following two new descriptions of close forms though taken outside Egypt.

188a. *Thalerastria alfierii erythra* subsp. nov.

This form of the above species has a reddish-orange ground colour of forewing and is rather smaller (21-22 mm.). Holo-Type (♂) : 14.xii.44, Buraiman, South-West Arabia, leg. A.R. Waterston (Middle East Anti-Locust Unit); British Museum. Allo-Type and one Para-Type (♀ ♀) : 8.xii.44, same place and captor (colls. Wiltshire and British Museum).

Another Para-Type (♂) : 18.xi.44, same place and captor, coll. E.P.W.

188b. *Thalerastria rex* spec. nov. (fig. 52).

A new species very close to *Eulocastra tamsina* Brandt (= *tamsi* Brandt *praeoccupata*), differing from the smaller examples thereof by its wavy, not straight, forewing bands, and also in the male genitalia (cf. figs. 46 and 51). See my remarks above under *T. alfierii* (No. 188) for the generic attribution of these two new species.

The type lacks both palps. Hindwing veins 3 and 4 are stalked (see fig. 47).

Head, thorax, basal area and median band of forewing, sooty black. Rest of forewing, pale whitish ochreous, tinged with rose near outer margin. Median band, broad, with inner and outer borders forming roughly parallel curves and angles (in contrast to *alfierii* where they "reflect" each other, as in a mirror). The most noticeable curve is a semi-circular outward bulge below the cell. The outer border of the basal area, however, tends to go contrariwise, being obtusely angled inward on the cell. Sub-apical spot on costa, and terminal border, sooty black, the latter broadly interrupted on vein 2. Hindwing, whitish ochreous, hardly marked. Span : 21 mm.

Holo-Type (♂) : 23.viii.44, Khamis Mushait, c. 8000 ft., Asir Mountains, South-west Arabia (leg. A.R. Waterston, Middle East Anti-Locust Unit). British Museum.

189. *Tarache lucida* Hufn.

So far only known from the Mariout, for the examples from Sinai have proved to be specifically distinct. Nevertheless it probably inhabits

Northern Sinai and might be found elsewhere in Egypt, for it is a Mediterranean and Tropical species and also inhabits steppes to a certain extent. It is very variable and all the wet and dry forms, from var. *lugens* to var. *insolatrix* have been taken in Egypt. Two of these and the male genitalia were illustrated in my article « Middle East Lepidoptera VII » in last year's Bulletin.

A probably multivoltine species, usually flying in Sub-Tropical dry climates in three generations, two in spring and early summer, and the third in autumn. The first, spring brood, usually contains a high percentage of dark « wet » forms, the subsequent broods of white « dry » forms.

190. *Tarache biskrensis* Ob.

One dark form, 27.iii.24, Wadi Isla (South Sinai), and one white form, 22.vi.13, Maadi; (A.A.). These were both illustrated together with the male genitalia in last year's Bulletin.

An Eremic species ranging from North Africa to South Persia.

191. *Tarache hemipentha* Wiltz.

One, mid iv.40, Wadi Isla, 1430 m., South Sinai (A.A.). An illustration thereof and of its male genitalia appeared in last year's Bulletin with the original description.

A Red Sea Eremic species.

192. *Tarache opalinoides* Guen.

One, iii-iv.28, Gebel Elba (A.A.); an unusually white form. An illustration thereof and of its genitalia appeared in last year's Bulletin.

An Old World Tropical species.

193. *Tarache crassivalva* Wiltz.

One, 27.iv.40, Wadi el Rabaa, Gebel Katherine, 1500 m., South Sinai (A.A.). The original description, with illustration and figure of genitalia, appeared in last year's Bulletin.

No other specimen is known yet, so the species appears to be an Eremic species endemic to South Sinai. But subsequent exploration may disprove this.

Sub-Family : Eutelianae

194. *Eutelia adulatrix* Hubn.

Flies in the Mariout and Alexandria vicinity.

Foodplants : not observed in Egypt, but elsewhere *Pistacia* and its related trees.

A Euroriental species, multivoltine.

Sub-Family : Sarrothripinae**195. Characoma nilotica Rog.**

One, iii-iv.28, Gebel Elba (A.A.). Also recorded on the North Coast in xi by Andres-Seitz (1923).

A very widespread Tropical moth.

Sub-Family : Acontiinae**196. Earias insulana Boisd.**

There is little to add to the remarks of Andres-Seitz (1923) except to draw attention to the account and coloured plate XII in Willcocks and Bahgat 1937. The yellow forms are later in appearance than the green forms except on desert ground.

A multivoltine Tropical pest, inhabiting desert and oasis throughout Egypt.

197. Microxestis wutzdorffi Pung.

New for Egypt. Specimens hereof were found in two local collections erroneously identified as *Porphyrinia minima* Guen., from which it is easily distinguished by the scaled bulge in the forewing hind-margin. Flies in the Delta and Alexandria in ix. Hitherto only known from Palestine.

Sub-Family : Phytometrinae**198. Syngrapha circumflexa L.**

Flies in iii, iv and v, in the Mariout, the Delta, Cairo and doubtless elsewhere in the Nile valley, and the Eastern Desert, e.g. 27.iii.35, Wadi Rishrash (A.A.) and 1.iii.28, Wadi Gelt el Agouz, extreme South-East Desert (A.A.). Observed in the desert at Giza in iii (E.P.W.). Hayward found it all the year round at Aswan, but most common in iii, vi, and xi.

Polyphagous on low plants and garden-flowers.

Euroriental, multivoltine, probably migratory.

199. Phytometra gamma L.

According to Andres-Seitz this moth is common all the year round in Lower Egypt. The available material however suggests this is not quite so: the only mid-summer example is a single specimen taken on 11.viii.26 at Sollum (A.A.). Petroff's material from the Mariout was taken in i, iii, iv and xi. The Cairo vicinity material (A.A.) was also taken in autumn, winter or spring. The desert specimens were taken in spring or early summer. There is no material at all from Upper Egypt; Hayward did not find it at Aswan. All this fits in well with the geographical status of this moth (it is Euro-Siberian) and its well-known migratory habits. The mass of the population dies out or emigrates from

Egypt in summer except for a few stragglers in the extreme north.

Multivoltine, polyphagous, sometimes a pest but not noticeably so in Egypt.

200. *Phytometra ni* Hubn.

All the year round on oasis ground in Lower and Upper Egypt; also inhabits the Mariout.

A multivoltine migratory garden pest, ranging from the Canaries, and Southern Europe to Eritrea and Japan.

201. *Phytometra chalcites* Esp.

Specimens from Alexandria district in i, ii, v, vi, vii and xi (P.), from the Cairo district in vi, x, and xi (A.A.) and iii and ix (E.P.W.). Apparently not known in Upper Egypt.

Multivoltine, but apparently aestivating in an early stage to avoid the hot dry weather, and similarly hibernating or at least retarded by winter except along the coast, where the mildness of winter evidently permits flight.

Food plants: garden plants and also wild herbs or shrubs of oasis habitat. It is not a desert moth.

A Tropical and Sub-Tropical Old-World species.

202. *Phytometra orichalcea* F.

Apparently only known from Alexandria district in summer.

A multivoltine Old-World Tropical species, feeding on garden plants; probably migratory.

203. *Phytometra daubei* Boisd.

Three, from Cairo vicinity: 10.x.24 and 20.iii.13, Maadi; v.20, Shubrah.

Also recorded by Andres-Seitz (1923) in other months and from further North in the Delta, and as feeding on *Pluchea dioscoridis*, a wild oasis canal-bank shrub.

A multivoltine Old-World Tropical species, perhaps migratory.

204. *Phytometra* (? *emichi* Rog. = *subspec.*) *maria* Stgr.

Common at various heights in the mountains of South Sinai in iv (A.A.).

This species also inhabits Palestine and probably Syria, Turkey, etc.

Sub-family: Catocalinae

For my treatment of this sub-family and my inclusion in it of the species usually, in the Old-World, treated as a separate sub-family, the *Noctuinae*, see my remarks above under the Group *Quadrifina*, and under No. 227 (below).

The right position of the first genus (*Crypsotidia*) is doubtful and perhaps it should not be in this sub-family at all.

205. *Crypsotidia maculifera* Stgr. (= *maculata* Tams).

I follow Rebel (1939) in regarding Tams' species described from Aswan as a synonym of Staudinger's earlier name, without having been able to satisfy myself of this. It flies at Aswan in v and vi, and has been recorded under the earlier name from the Sudan, Palestine, and Cyprus. I have not seen a specimen, and the moth seems to be rare in Egypt, at least in the North.

206. *Crypsotidia mesosema* Hamps.

Three examples of this Tropical African species were taken at Aswan in iii and iv, by Hayward. I have not seen a specimen.

207. *Anua tirhaca* Gr.

Multivoltine in Cairo and Alexandria districts. Larvae have been found on *Psidium* (Guava); elsewhere in the Sub-Tropics it is found on *Pistacia* and *Rhus*.

A widespread Tropical and Sub-Tropical Old-World moth.

208. *Ophiusa albivitta* Moore.

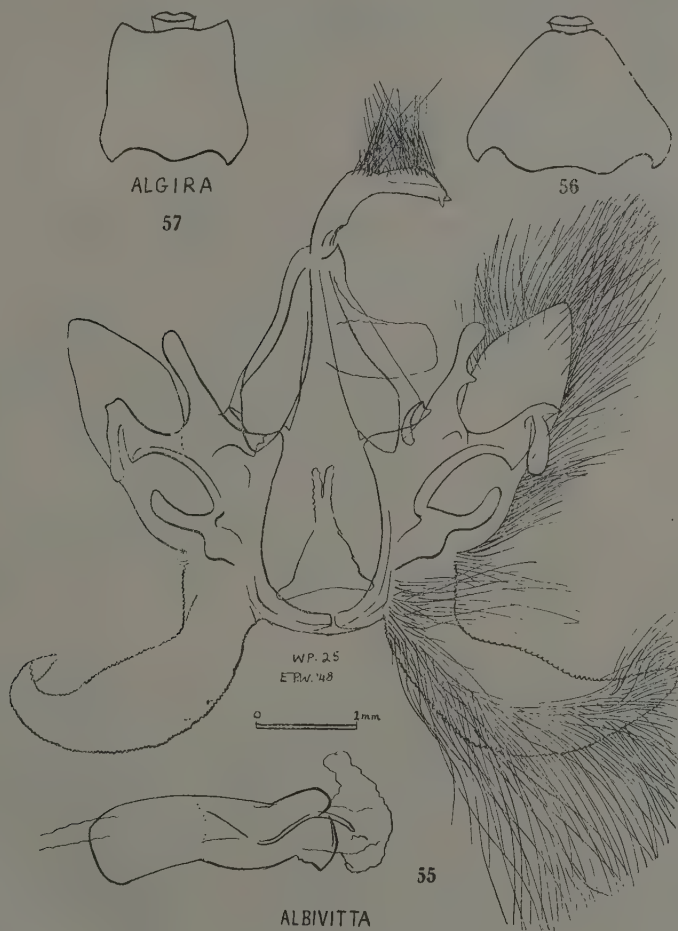
Previous authors have recorded *Ophiusa algira* L. from Egypt, including Hayward from Aswan, and all the material I have examined was in fact labelled *Algira*. *O. algira* is a Euro-Siberian species, *O. albivitta* an Old World Tropical species. Both have been found in the Eastern Mediterranean and the occurrence of *algira* in Egypt is not impossible but in my opinion all the specimens examined are *albivitta*, assuming that this is the right name for the second of the two similar *Ophiusa* species inhabiting the Eastern Mediterranean. I illustrate the criterion of the female genital plate, which readily distinguishes these two; the example of *algira* shewn (fig. 57) was from Cyprus, the *albivitta* (fig. 56) from Egypt. Superficially the two are hard to separate, but the white forewing fascia is straighter in *albivitta*, constricted angularly in *algira*. I have not had the opportunity to dissect Indian *albivitta* Moore. I also shew the male genitalia of the Egyptian species (fig. 55).

I have examined examples from Alexandria taken in vi, vii, viii and ix (P.), and from Cairo in iv and v (A.A.), and x (E.P.W.). The Cairo examples in coll. Alfieri were bred from larvae found on Castor (*Ricinus*).

209. *Grammodes geometrica* F.

A long series from Cairo, Beheira and Alexandria, taken from vii to xii (A.A.). A good series from Alexandria and Beheira, in iv, vi and vii (P.).

According to Andres-Seitz (1923) the foodplant in Egypt is *Polygonum*, but doubtless other plants and shrubs are eaten. The moth ranges through the Sub-Tropics and Tropics of the Old World, and is evidently multivoltine.



Figs. 55-57 : *Ophiusa* species : (55 and 56) *O. albivittata* Moore, (57) *O. algira* L. (Cyprus); (55) ♂ genitalia, ventral open view, with aedeagus separated; (56 and 57) ♀ genitalia, genital plate only.

210. *Grammodes stolidus* F.

One, 7.ii.13, Bacos (Ramleh, Alexandria) (A.A.). Recorded also by Seitz (see Andres-Seitz, 1923) from Ismailia, Canal Zone.

A Mediterranean moth, ranging eastwards to South Persia; probably multivoltine.

211. *Grammodes boisdeffrei* Ob.

Flies at Montaza, Aboukir Road (near Alexandria), in v, vi, vii, viii and ix (P.); in the Eastern Desert and Sinai in iv and ix (A.A.).

An Eremic species occurring in North Africa and Palestine.

212. *Chalciope hyppasia* Cr.

One, iii-iv.28, Gebel Elba (A.A.).

An Old-World Tropical moth.

213. *Gyligramma latona* Cr.

One, 13.iv.40, Bir Tarfa, South Sinai, 1430 m. (A.A.).

An Old-World Tropical moth.

213a. *Sphingomorpha chlorea* Cr.

On p. 68 in Andres-Seitz (1923), Seitz guesses that the Tropical African migrant *chlorea* will one day be taken in Upper Egypt. He had overlooked the capture of a single specimen of it at Luxor, by Rothschild recorded on p. 431 of *Nov. Zool.*, 1909. I myself overlooked this record until the list had gone to press. There can be no question of a mistaken identity, so the species can be added to the Egyptian list, where its status is that of a rare immigrant. No further specimen has been noted. Rothschild gave the form as *monteironis* Butler. The moth is a large fruit-piercing handsome species, which has been mistaken for a Hawkmoth (Sphinxid) not infrequently.

214. *Scodionyx mysticus* Stgr.

In view of the great variability of this species on a single habitat, I doubt whether any of the various local forms that have been described of this widespread Eremic moth can be held to denote subspecies. There are two bred from larvae on *Acacia tortilis*, found on 3.iii.26 in the plain between the North and South Galala plateaux in the Eastern Desert which hatched (♂ ♀) on 23.iv.26 and 1.v.26 (A.A.). These are brown and well-marked. A third specimen, ♂, 1.iii.26, Wadi Ascar (A.A.) (practically the same locality) is devoid of markings and coloured pale sandy buff; its quadrifid hindwing neuration had been overlooked and it was placed in the series of *Eumichtis aurora aegyptiaca* Wilts. (No. 119 above), and indeed regarded as a para-type until, thinking it might rather be *Eumichtis lea* than *aurora* I examined its genitalia and at once recognised it (the male genitalia were illustrated by Warnecke 1940 (*Mitt. Muench. Ent. Ges.*, XXX, h. 3, p. 850). Some others of the *aurora* series were equally pale but none quite so unmarked.

The larva has not been described hitherto. The following description is therefore given, made from skins of other larvae taken at same time and place as those producing the two adults mentioned above. Of these larvae Monsieur A. Alfieri noted : « living in colonies under the bark of *Acacia tortilis* ». No doubt they hide by day in this position and feed by night on the leaves, as is the case with *Pandesma anysa* (No. 233 below) which I observed similarly swarming under loose bark of *Populus euphratica* at Bagdad, and whose larva is curiously similar.

The larva is remarkable, for a Quadrid, in having all five pairs of abdominal claspers fully developed, which shows that the obsolescence of the first pair, so often mentioned as a criterion of the Quadrid moths, is not an absolute character. The head is glossy brown with five ocelli on either side. Thoracic and anal plates, brown. Dorsal stripe, broad, clear, white with purple interior dappling and heavy black edging on either side; dorsal area blackish; subdorsal stripe, pale grey above, double and black below; lateral rosy and white dapplings on a grey field just above the spiracular stripe, which is grey-centred, double and black; spiracles, black; both subdorsal and spiracular stripe black lines are finely interrupted and rather wavy. Underside, unpigmented.

An Eremic species distributed from Arabia to Morocco.

215. *Clytie illunaris* Hubn.

One, hatched 7.ix.26, from larva on tamarisk, Sollum, whence also there is a preserved skin (A.A.). Three, hatched vi and vii, Sidi Gaber (Ramleh, Alexandria) (P.).

A Mediterranean species, multivoltine.

216. *Clytie haifae* Habich.

More widespread in Egypt than the foregoing, having been found not only in the North (e.g. Mariout, Ramleh, etc.) but southward to Cairo and Maadi at least. The genitalia were illustrated, for comparison, in last year's Bulletin in the description of its Tropical close relative *subaea* Wlts., which also occurs in Eritrea (ne-Allo-Type (♀), 10.i.48, leg. A.R. Waterston, M.E.A.L.U., Maaba, coastal plain, Eritrea, in coll. mea).

This multivoltine moth, like the whole genus, feeds on tamarisk. It also occurs in Palestine and on the Lebanese coast.

217. *Clytie sancta* Stgr.

Four, to light, 27.iii.35, Wadi Rishrash (Eastern Desert); one, 11.viii.18 Dakhla Oasis (Libyan Desert); one, 10.xi.24, Kharga Oasis (Libyan Desert); (A.A.). For the male genitalia, see figure 58.

Multivoltine, feeding on tamarisk. A North-African Eremic species also inhabiting the coast of Lebanon and Palestine, perhaps also Arabia. It has

also been recorded from South of the Tropic of Cancer in Africa (Dancalia), on which I can express no opinion.

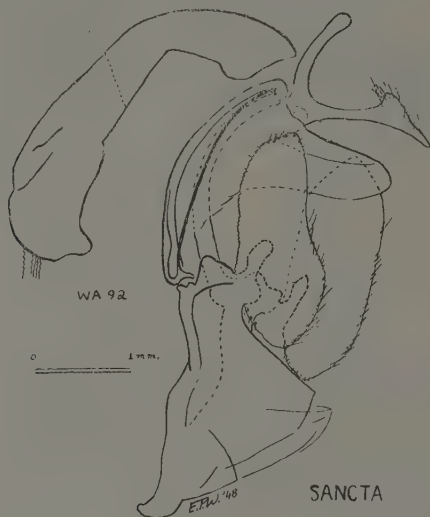


Fig. 58 : *Clytie sancta* Stgr., ♂ genitalia, lateral view, with aedeagus separated.

218. *Hypoglaucitis benenotata moses* Stgr.

Probably more widespread in Egypt even than indicated by the material, which is from the Alexandria and Mariout districts, from Mena (near Cairo), and from the Siwa and Bahariya Oases to the South-West. Obviously a close relative of the three preceding species.

Multivoltine, on tamarisk. Eremic, ranging from Morocco to India.

219. *Pericyma squalens* Led.

One, Kantara (Canal Zone), 2.ix.16; one, 19.vii.20, Cairo (A.A.); two, 10.vii.47, Cairo (E.P.W.).

An East Mediterranean moth.

220. *Cortyta acrosticta* Pung. (= *rosacea* Rebel).

One, vii.35, Hurgada (Red Sea Coast); one, 2.iii.28, Wadi Kiraf (extreme South-East desert of Egypt); one very small specimen, Suez Road (Eastern Desert), 8.v.24; (A.A.).

A widespread Eremic species, apparently dependent on *Acacia*.

221. *Cortyta dispar* Pung.

One ♂, 25.iv.24, Noucibat, East Sinai (A.A.).

A widespread Eremic species.

222. *Anydrophila fouadi* Wilts.

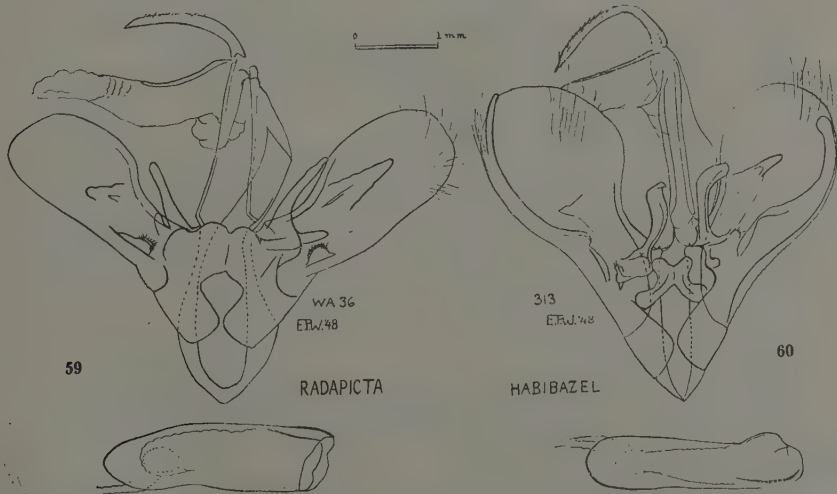
Described and illustrated in colour in last year's Bulletin. Evidently common in iv, and probably repeatedly through the year, in the mountains of South Sinai. A darker grey specimen has been also taken in Jebel Shammar (North Central Arabia).

223. *Cerocala sana* Stgr.

Inhabits the Mariout, the Eastern Desert and Sinai flying principally in two broods, a vernal and an autumnal, the latter sometimes rather late in the year; there is however also one specimen taken on 8.viii.13, desert near Helwan (A.A.). The form *albifusa* Joannis is similarly an August form and may be regarded as a « dry » reaction to heat and drought. It is striking how in the West of the Eremic Zone this genus has produced a number of species but in the East, beginning in Egypt, there is only one, the widespread *sana*, which ranges eastwards to South Persia.

224. *Leucanitis picta radapicta* Stgr. (Plate I, fig. 14).

I follow Andres-Seitz in thus identifying the *Leucanitis* species of the Eastern desert, not having been able to examine types or specimens



Figs. 59 and 60 : *Leucanitis* and *Syneda* species, ♂ genitalia, ventral open view, with aedeagus separated. (59) *Leucanitis picta radapicta* Stgr., (60) *Syneda habibazel* Dumont.

of *picta* Christ. or *radapicta* Stgr. It is bivoltine, flying in spring and autumn (ii-iv and again in xi). The genitalia are shewn (fig. 59).

An Eremic species, ranging eastwards into Central Asia.

225. *Leucanitis kabyalaria* B.-H.

Thirty specimens, iv.40, various heights, mountains of South Sinai (A.A.).
An Eremic species occurring from Morocco to South Persia.

226. *Syneda* (= *Alcucanitis*) *flexuosa* Men.

Two, El Alag, 25.iii.13 and 8.iii.14; one, 16.iv.27, Bir Odeib (shores of Gulf of Suez, Eastern Desert); one, 17.ix.25, Abu Sultan; one, Geneifa (Canal Zone), 18.v.25; (A.A.).

A multivoltine Eremic species ranging eastwards into Central Asia.

227. *Syneda habibazel* Dumont (Plate I, fig. 15).

One, 16.iv.27, Bir Odeib (shores of Gulf of Suez, Eastern Desert) (A.A.). The genitalia are illustrated (fig. 60) to shew the affinity between *Syneda* and *Leucanitis* (fig. 59), and the unnaturalness of putting these two insects into separate sub-families; note also the similarity of facies as shewn in the Plate.

An Eremic species ranging from North Africa to Arabia.

228. *Africalpe nubifera* Hamps. (= *intrusa* Krüger 1939).

One, 30.v.24, Wadi Digla (near Maadi, Eastern Desert) (A.A.).

An Eremic species ranging from North Africa to South Persia.

229. *Acantholipes circumdatus* Walker.

Two, iii-iv.28, Gebel Elba; one, 14.ii.17, Biahmo; (A.A.).

A Tropical African species, only known from the extreme south.

230. *Anumeta atosignata spilota* Ersch.

One, 30.viii.16, Romani (North Sinai); others in iv.40 from South Sinai, various heights; (A.A.). One, 14.iv.26, Wadi Natroun (P.). Petroff's catalogue (i.l.) also mentions a second specimen caught on 30.iv.25 in Wadi Gharbah (Mokattam hills, Eastern desert), but this, or the preceding, is missing.

An Eremic species ranging from North Africa far into Asia.

231. *Anumeta arenosa* Brandt

Two, iv.40, 300-700 m., mountains of South Sinai (A.A.).

Previously only known from South Persia; an Eremic species.

232. *Anumeta straminea* (B.-Haas).

One 3.ii.17, El Romani (North Sinai); one, 1.iii.26, Wadi Ascar (Eastern Desert); one, 18.xii.25, Bahariya Oasis (Libyan Desert) (A.A.). Three, 31.i.48, sandy desert near Giza Pyramids, West of Cairo, and a fourth there in 7.iii.48 (E.P.W.).

The phenology probably denotes the extended emergence of a single brood during the cool months.

An Eremic species inhabiting North Africa and Arabia.

233. *Pandesma anysa* Guen.

A long series from Alexandria and the Mariout in xii (P.). Observed at Aswan from iii to xi by Hayward.

Foodplant: Labbakh (*Albizzia lebbek*), and probably other trees.

A multivoltine Tropical migratory species, widespread in the Old World.

234. *Armada dentata nilotica* B.-H.

Although Bang-Haas described this form from Egypt it has also been erroneously recorded under the name *hueberi* Ersch.. The difference in frons between these two species is quite clearly given in Seitz III and according to that all the Egyptian so-called « *hueberi* » that I have examined (i.e. the greyer specimens) are in fact *dentata* forms. Of these grey forms, three come from North Sinai (9.v.17, 9.vi.17, El Arish, and 22.v.35, El Arish, leg. Rabinovitch), and one from km. 100 on the Suez Road, Eastern Desert, 21.vi.36; the white specimen, which seems to agree better with *nilotica* as described by Bang-Haas, is also from the Suez Road, but taken on 14.ix.34; (A.A.). Perhaps the whiter form is seasonal; from the material available it does not seem to be characteristic.

This Eremic species ranges eastwards to South Persia and Central Asia.

235. *Armada eremophila* Rebel (= *costiplaga* Warren).

One, 23.x.12, Maadi; one, 23.ii.17, Romani, North Sinai; (A.A.). Also from Sinai (Rebel, 1909) and Wadi Natroun (Warren's types).

Bivoltine (?); an Eremic species.

236. *Armada plumbizonata* (Hamps.).

The difference in male genitalia between apparent examples of this species (described from Suez) and the preceding (No. 235) is so slight that they may be synonymous, in which case *plumbizonata* is a mere variety of *eremophila*. Two, 24.ix.25, Wadi Murrah, Eastern Desert (A.A.).

An Eremic species.

237. *Armada turcorum* Zerny.

New for Egypt. One, 6.iv.21, Hammam (Mariout).

An Eremic species inhabiting steppes and deserts in North Africa and South-West Asia.

238. *Acrobyla kneuckeri* Rebel.

Has not been retaken in Egypt since the types found by Kneucker in Sinai. But it has been found elsewhere in the Saharan-Sindian Eremic region, i.e. eastwards to Karachi (where it occurs in the form *ariefiera* Hamps.) and westwards to Morocco where the form *gloriosa* Rungs flies.

A bivoltine moth with vernal and autumnal broods.

239. *Raparna conicephala* Stgr.

Five, iii-iv.28, Gebel Elba (A.A.). New to Egypt.

An Eremic species ranging from Spain to South Persia.

240. *Rivula sericealis tanitalis* Rebel.

Flies in the Cairo and Alexandria districts.

Multivoltine, a grass-feeder, fond of moist habitats; doubtless only to be found in Egypt in oases.

A Euro-Siberian moth.

241. *Rhynchodontodes revolotalis* Z.

As I have already pointed out this is the earliest name for the widespread Eremic species also known as *syriacalis* Stgr. and *eremialis* Walk.. The original description mentioned South Africa as the habitat but this seems to be wrong. I consider it distinct from *ravalis* H.-S.. It is widespread on oasis and also on desert ground in Lower Egypt and the Eastern Desert, and flies in repeated broods, throughout the year. A series which I recently took flying by sunlight at Bulac Dacrur, near Cairo, were all remarkably worn, so that the characteristic long palps and frontal scale-tufts had been broken off or rubbed away by contact with the *Alhagi* bushes among which they flew; their un-«snout»-like appearance made me think they might be a different species until I examined the genitalia.

An Eremic species ranging eastwards to North-West India.

242. *Hypena lividalis* Hubn.

One, 10.ix, 22, Ramleh (Alexandria), (A.A.).

This Mediterranean species was once reported from Socotra and has also been recently taken South of the Tropic in coastal South-West Arabia! Its foodplant in Mediterranean regions is *Parietaria*.

Family : LYMANTRIIDAE

In passing it should be remarked that the family *Notodontidae* is apparently unrepresented in Egypt.

243. *Orgyia dubia judaea* Stgr.

Flies in the Northern Delta and near Alexandria all the year round.

According to Andres (1923) the foodplant is *Suaeda fruticosa* but the larva is usually polyphagous elsewhere and may be so in Egypt. Multivoltine.

A Pan-Eremic species, ranging from North Africa to Central Asia.

244. *Casama flavipalpata* (Stgr).

I follow Zerny (1935) in attributing this species to the above genus rather than *Ocneria*. I do not follow him, however, nor Kruger, in con-

sidering the Atlas and Cyrenaican forms, *brauni* (Aud.) (= *leporina* Zerny) and *alfierii* Kruger, respectively, as specifically distinct. In Egypt the dark form *alfierii* occurs about as frequently as the white form *flavipalpata*. The species is not even always white in its easternmost habitat (Arabia); if it really becomes darker westwards, this may be regarded as an adaptation to wetter conditions, but the variation may be seasonal rather than geographical.

The species seems to be common on *Acacia tortilis* in certain desert valleys, e.g. near the Galala plateaux and on the Suez Road in the Eastern Desert; it also inhabits the Gebel Elba, South-East Egypt (Tropical Acacia woodland), and has been taken in numbers in and around Alexandria. One pale specimen was bred in 6.xi.23 from *Acacia nilotica* («Sunt») at Giza, near Cairo; (A.A.). It also inhabits Sinai, where it was taken commonly at Bir Tarfa, at 1430 m., etc., in the southern mountains in iv.40. (A.A.) Multivoltine.

A Saharan-Arabian Eremic species.

245. *Euproctis susanna* Stgr.

To light 23.iii.27, Wadi Ascar (Eastern Desert), and also bred from larvae on *Ochradenus baccatus* in iv.35, Wadi Hof and Wadi Abu Goufan, Eastern Desert (A.A. & P.). For description of larva, see Andres-Seitz 1923).

Apparently univoltine. Eremic, known only from Egypt, Arabia and Palestine.

246. *Euproctis charmotanti* Vuillot.

One ♂, Tina (near Port Said), 19.vi.25, « among grass at foot of tamarisks » (A.A.).

A rare North African Eremic species.

Family : ARCTIIDAE

Sub-Family : Spilosominae

247. *Spilosoma arabica* Hamps.

Eight, various heights, iv.1940, South Sinai (A.A.). Originally found in Arabia. Eremic.

Sub-Family : Micrarctiinae

248. *Ocnogyna loewii* Z.

Flies in the Mariout in x-xii. One evidently belated cycle is indicated by a female specimen marked « pupated vii.1912, hatched iii.13 », (A.A.). The Mariout form is intermediate between var. *clathrata* Led. and var. *mutata* Turati.

The larva is polyphagous. Univoltine autumnal.

An East-Mediterranean moth ranging into Central Asia.

249. *Utetheisa lotrix lepida* Ramb.

For the genitalia of both sexes, whereby this species can be distinguished from the following see K. Jordan (*Nov. Zool.*, XLI, 1939, p. 287, ff.). Dissection is unnecessary, but little reliance can be placed on trying to distinguish the two by wing-markings.

In the material at my disposal there is no specimen of *lotrix* taken West of the Nile nor far North of the Suez Road. There are examples from Maadi and Tourah taken in v, from Gebel Elba (iii-iv) and Suez Road (viii and x) (A.A.), iii (E.P.W.).

A Tropical species ranging from Egypt to West Africa, and the Fiji Isles and New Caledonia.

250. *Utetheisa pulchella* L.

More variable than the previous species in markings and apparently more widespread in Egypt, to judge from the available material. Inhabits the Mariout and the desert on both sides of the Nile valley.

Besides the usual foodplant *Heliotrope*, I have found and bred the larvae in winter near the Giza pyramids on *Lithospermum callosum* (E.P.W.). Multivoltine.

This Tropical species is more widespread in the Sub-Tropics than the preceding one; it is a well-known migrant, often invading Temperate territory, temporarily. It ranges to West Africa, Burma and Ceylon; in the Palearctic Region its range is Euroriental.

Sub-Family : Nolinae

This sub-family will be dealt with in the next part together with the families Geometridae, etc.

A D D E N D U M

While the foregoing Part I was in the press I have been kindly permitted to examine two further collections in Cairo. Consequently 26 more species, belonging to the families catalogued in Part I, can now be added to the Egyptian Lepidoptera, including two more new to science, *Cucullia efflatouni* (No. 105 a), and *Propsalta coptica* (No. 143 a), described hereunder.

The same opportunity enables me hereunder to describe for the first time the early stages of two more species : *Chilena obliquata* Klug (No. 63) and *Armada dentata* Stgr. (No. 234). Of the former I am also able to describe the hitherto unknown male.

In Part II, which will, it is hoped, appear next year, my main list will therefore include the data of four different collections seen in Cairo. In this Addendum, however, I have only included new data for species already named in Part I in cases where the newly seen material strikingly added to the known range of the species, or to the knowledge of its biology.

Mention must also be here made of the quite recent posthumous publication in Vienna of new species from Egypt described by Dr. Hans Rebel (*Neue Heteroceren aus Aegypten, Zeits. Wiener Ent. Ges.*, 32 Jg., 10th May 1948, Nos. 5-7, pp. 49-60). No illustrations are given, and the whereabouts of the types is not stated. It had been the intention of the late Dr. Rebel to include these new descriptions in a comprehensive work on the Lepidoptera of Egypt, which he never lived to complete. The editor of this publication, Dr. Hans Reisser, to whose kindness in this connexion I am greatly indebted, informs me that the work as a whole has not survived in a publishable state and was never completed; on discovering the manuscript, as the result of my own enquiry about it, Dr. Reisser extracted the new descriptions and published them. These new species are nearly all from the extreme South-East of Egypt (Gebel Elba district). Dr. Reisser informs me that he had found the type of one of these new species, *Nola priesneri*, in Vienna, but not of the others. I have accordingly searched the Caire collections for the types of the others with the following results:

In only two cases did I find examples actually labelled with the specific names of Dr. Rebel; these two cases are the two *Ozarba* species in coll. Alfieri mentioned in Part I above (Nos. 184 and 185), and both are, as there stated, synonyms. In certain other cases I was able to identify the species by comparing Dr. Rebel's descriptions and data with the examples and their labels; in these cases however there is no evidence that the same specimens were seen by Dr. Rebel, so they are topo-types rather than real types. In eight cases, however, no specimen could be found corresponding to the 1948 description. The details are given below.

It is regrettable that several of Dr. Rebel's names will therefore probably remain obscure to future students, but I have done my best to identify and evaluate these descriptions, in what follows. I leave to Part II mention of those belonging to the *Nolinae* and *Geometridae*.

I am indebted to Efflatoun Bey for letting me see and examine specimens in the collection of the Entomological Section of the Faculty of Sciences, Fouad I University, Abbasia, Cairo. I am also greatly indebted to Mohammed Tewfik Effendi for his personal assistance during my visits there. This material has for the greater part, or at least the most interesting part, been collected by these two active entomologists in the last decade in South Sinai.

I am indebted to Mo'amed Soliman El-Zoheiry Bey for letting me see and examine specimens in the collection of the Ministry of Agriculture, Doqqi, Cairo. I am also very grateful to Professor H. Priesner and to Abdul Hamid Ibrahim Ibrahim Effendi, for their co-operation on my visits there. This material is from many sources, and some of it goes back thirty years; there is however some important and more recent material collected by Prof. Priesner and Abdul Hamid Effendi in Upper Egypt; this rich material is mostly from the Gebel Elba region, but also from a new locality, not mentioned in the introduction to Part I, viz. Oweinat, in the extreme South-West. The high isolated mountains of Gebel Oweinat are apparently a purely Eremic habitat, lacking the Tropical rains of the Gebel Elba heights.

In the list which follows, the species not in brackets are those I have seen in Cairo and which are, in nearly every case, new to Egypt. Those in brackets are those already named in Part I above, of which further particulars are here given. Those in smaller type are Dr. Rebel's 1948 names of which I could not see specimens.

ABBREVIATIONS

E = collected by Efflatoun Bey and Mohamed Tewfik Eff., now in Fouad Ist University.

M = in the collection of the Ministry of Agriculture.

LIST

(13a. *Anthene amarah* Guer.).

10.vii.43, Wadi el Lega, South Sinai (E.).

28a. *Philotes astabene* Hemming (= *clara* Stgr., *praeoccupatum*).

One ♂, 4.viii.42, Wadi el Lega, South Sinai (E.), identified by genitalia.

Eurooriental.

42a. *Colotis halimede* (Klug).

28.i.33, Wadi Kanisrob, Gebel Elba (M.). A Tropical African and Arabian species.

42b. *Colotis ilagore* (Klug).

Three, i and ii, Gebel Elba district (M.). A Tropical species ranging from North Nigeria to South Beluchistan.

42c. *Colotis protomedia* (Klug).

Gebel Elba region (M.). A Tropical African and Arabian species.

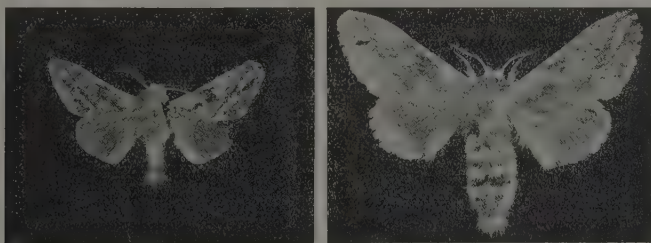
(63. *Chilena obliquata* (Klug). (Figs. 61 and 62).

I have seen (M.) a nice little series of both sexes and a larval skin,

collected by Boyd in the Canal Zone and North-West Sinai in 1916 (see *Bull. Ent. Soc. Egypte*, V, 1917, p. 98).

The hitherto undescribed male has bipectinated antennae, the shaft being white, the pectinations ochreous.

Head and thorax, pale grey; abdomen, yellowish grey. Forewing, pale grey infused with darker grey. A diffuse whitish long discal spot lies parallel to the oblique fascia. A wavy dark line runs back from the discal spot roughly parallel to the costa towards the base; oblique fascia, pale, dark-edged, from



61

62

Fig. 61 : *Chilena obliquata* (Klug), ♂. — Fig. 62 : *Chilena obliquata* (Klug), ♀.

apex to about 2/3 inner-margin; its inner edge is straight, its outer edge indented on the median nervure and again near nervure 1. Fringe, whitish-grey. Hindwing grey, paler basad. Fringes, whitish-grey.

Underside, both wings, similar to upper sides but less distinctly marked; the nervures are here paler in the submarginal field.

Span : (♂) 30 mm., (♀) 42 mm.

Ne-allo-Type : ♂, 19.ix.16, Katia, North-West Sinai, in coll. Ministry of Agriculture, Doqqi, Cairo.

Thus the character which Andres-Seitz (1923) stated to separate this species from *sordida* Ersch., viz., the pale discal spot present in the latter, is, it proves, also present in the Egyptian species, but is apt to be obsolete in the paler female. I have therefore decided to illustrate both sexes of Klug's species herewith (figs. 61 and 62); from the early stages, described below, it is clearly seen to be a quite distinct species from the Central Asian *sordida*.

It seems safe now to dismiss not only the Andres-Seitz record of *sordida* from Egypt but also other records of *sordida* from North Africa, including that of Rebel from the Algerian Sahara in which the difference in ground-colour (brown in *sordida*) is admitted (Rebel, 1895, *Verh. der*

k.k. Zool.-bot. Ges. in Wien). The inadequate account of *obliquata* both in Klug's original description and Seitz, Vol. II, is partly to blame for these wrong records. I suspect the Algerian species is none other than *obliquata*.

The hitherto undescribed larva is quite unlike the larvae of its two congeners, *sordida* and *proxima*, which I described in detail in *Ent. Rec. and Journ. of Variation*, LII, pp. 71-72. The head is blue-grey, the thoracic feet black, the abdominal feet black, brown-marked; the dorsum of somite 1 is blue-grey, the under-side of the whole larva black and orange; the short anal tuft is orange. The following particulars may be compared with the table describing the other two congeners:

Tuft on somite 2, black and vermilion. Tuft on s.3, black and yellow. Dorsal line, cream-coloured, black-edged, with pale brown hairs. Dorsal area's coloration extends to lateral line, and is blue, with two transverse red black-edged bars per somite, and other black and grey marks; the subdorsal line is absent, but there is a series of subdorsal spots; these are large, isolated, pale creamy-grey, one per somite. On the sides the dorsal coloration is more intensely freckled with black, and there are three heavy black spots just below the subdorsal spot. The lateral line is not clear, merging with the blue dorsal area, to which it is the lower edge; it is formed of black and creamy mottling; below it is the sublateral area, pale lilac-blue with long whitish hairs. Spiracles, ochreous, black-rimmed.

The cocoon is grey and papery and spun up on foodplant twigs (*Raetama raetam*).

(64. *Dendrolimus alfierii* Andres-Seitz,

South Sinai (E.).

75a. *Aegocera brevivitta* Hamps.

Two, 24 and 31.i.33, Gebel Elba (M.).

This Tropical species is the first of the family *Agaristidae* to be taken in Egypt.

(84. *Agrotis sardzeana* Brandt).

10.i.33, Wadi Garara, South-East Egypt (M.); also at Oweinat, South-West Egypt (M.).

88a. *Agrotis pictifascia* Hamps.

22.i.33, Gebel Elba region. I have before me copious material from South-West Arabia, from Eritrea, and South-East Egypt, and while doubtless the differences between Rebel's types and Hampson's text are real, I do not think *elbaensis* Rebel (1948) is separable as a race or form, and incline to regard it as a synonym. The genitalia, however, of Hampson's type, have not been investigated. The species inhabits the Tropical coastal

desert (Arabic : Tihama ; Italian : Basso Piano) of both sides of the Red Sea, and also penetrates inland in places to quite a height, as in Asir. The Egyptian locality seems to be its North-Westernmost limit, and is still within the Tropics.

89a. *Ochropleura (Dichagyris) melanuroides* subspec. *leucomelas* Brandt (1941).
(Muench. Ent. Ges., heft III, p. 843, pl. XXIV, fig. 15).

One male, 10.iv.40, Karm Alam, South Sinai (E.). A most interesting discovery ; this vernal univoltine moth was known previously only from the mountains of Iran and Central Asia. The genitalia, particularly the aedeagus, distinguish it from *melanura* Koll., which the race of Iran and Sinai resembles superficially. The later species, *melanura*, is known from the Balkans, Iran and the Lebanon, but not from Egypt.

98a. *Hadula pulverata* Bang-Haas.

A good series, 11.iii.37, Wadi Ashkar, Eastern Desert (M.). These specimens were returned from Vienna identified as *Hadula sabulorum* Alph., but the male genitalia do not agree with that Central Asian species. The species *pulverata* is North-African Eremic ; vernal, univoltine.

99a. *Miselia dysodea* Schiff. (= *Polia spinaciae* View.).

10.vii.43, Wadi el Lega, South Sinai (E.). A variable series probably best referred to f. *caduca* H.-S. Euroriental.

105a. *Cucullia efflatouni* spec. nov. (Plate VI, fig. 5).

Possibly a race of the Central Asian *hemidiaphana* Graeser, which I have not been able to examine, and next to which it can be placed.

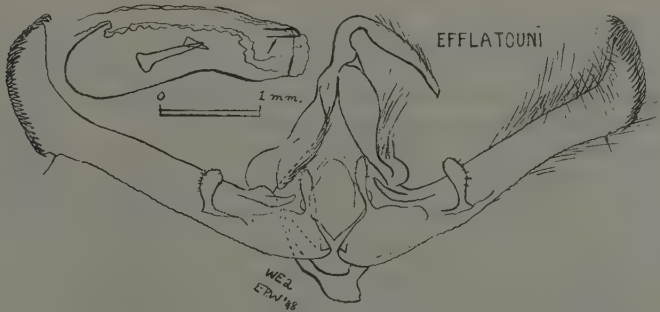


Fig. 63 : *Cucullia efflatouni* nov. spec., male genitalia, ventral open view with aedeagus separated.

Antenna, simple ; foreleg, without spines.

Forewing, white with clear dark-grey and black markings, as follows : a long fine basal streak in a white field ; three pairs of black dots in the

cell; a white median field below the cell defined by two fine angulated lines. Nervures, blackish. Between them in the marginal area, grey shades. Costa, grey with white dots and blacker marks. Orbicular and reniform stigmata, white-outlined but indistinct. Fringes, grey, white-chequered. Hindwing, diaphanous whitish, slightly pearly; nervures, brown-grey near termen which is faintly brown. Fringes white. From *hemidiaphana* as described in Seitz this form differs in its grey forewing fringe, white forewing ground colour, devoid of ochreous tinge, and stronger-marked hindwing. Span: 31-35 mm. The male genitalia of *efflatouni* are shewn (fig. 63).

Holo-Type: ♂, 20.vii.40, Wadi el Lega, South Sinai, taken by Efflatoun Bey, coll. Ent. Dept. Fac. Science, Fouad I University, Cairo.

Allo-Type: ♀, 22.xi.26, Um Arad, Sinai, leg. Kaiser, in coll. Alfieri (det. by Tams, according to label thereon: a *Cucullia* spec. n. It appears that another example was retained by the British Museum, when this one was sent).

Para-Type: ♀, 10.ix.28, Farsh el Arab, Sinai; in coll. Alfieri.

105b. *Cucullia macara* Rebel (1948).

I could find no example in Cairo corresponding to this description (Gebel Elba).

(114. *Metopoceras eutychna* Rebel (1948)).

The Sinai species, referred to by me in this Bulletin 1947 as *canteneri* Dup., has recently been described as distinct, and I now incline to agree with Dr. Rebel that it is separable. It also inhabits Western Arabia, and is common in South Sinai (Egypt) in April. Only females have been taken yet. They correspond to Dr. Rebel's description.

134a. *Bryophila divisa* Esp.

25.vi.33, Ikingi Mariout, leg. Abdul Aziz (M.). Euroriental.

(143. *Propsalta capensis* Guen.) and 143a. *Propsalta coptica* spec. nov. (= *capensis* Andres and Seitz 1923, Storey 1916, nec Guenée).

A single ♀ (M.), from Mersa Halaib, 6.ii.33 (the Red Sea port of the Gebel Elba district) perfectly agrees with the Warren-Seitz text and plate (Vol. XI) of the widespread Tropical species *capensis* Guenée. (The plate of *capensis* in Seitz, Vol. II, is too confused to be of use). It was strikingly different in aspect from the Cairo form which for about thirty years has been called *capensis*, and of which biological and other details are given in Part I above with an illustration of the ♂ and ♀ genitalia (figs. 34 and 35). Examination of the genitalia of the Mersa Halaib form at once confirmed its specific distinctness, and these parts are shewn herewith in fig. 64. The absence of signa on the smaller, rounder bursa, and the broad, weaker, purse-shaped ostium bursae are obvious points of difference, and these characters would make the species illustrated more akin to *Hadjina viscosa* and

palaestinensis (see figs. 32, 33 and 36) than to the *Propsalta* from Lower Egypt, which I here provisionally describe as a new species *coptica* (= *capensis*, fig. 29, Pl. I, Andres-Seitz, 1923).

The new species does not correspond to the detailed descriptions of *capensis* by Warren in Seitz II and XI; I presume that Storey and his followers preferred to rely of the confused coloured plate in Seitz II than read carefully the text of the same volume, or refer to the good plate in

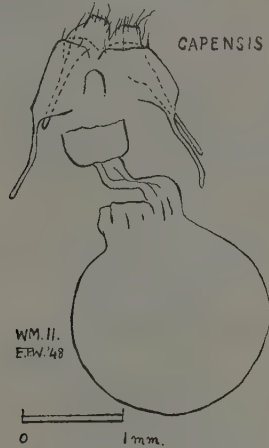


Fig. 64 : *Propsalta capensis* Guenée, female genitalia, ventral view.

Seitz XI. It is similar in abdominal tufts, palp-shape and size to the Mersa Halaib *capensis*, but lacks all black scales on palp, thorax and wing, except for minute black points on the nervures outside the forewing post-median fascia; it has a powdery mauve-brown aspect, not glossy dark yellow-brown as in the other; all the forewing markings are fainter and in particular it lacks the yellow upper centre and white lower centre to the reniform stigma with its encircling white dots, typical of *capensis*. It also lacks the small black submarginal wedges of that species. The large reniform stigma is blurred and pale, and sometimes even obsolete; the smaller orbicular stigma is pale and more frequently obsolete. The general aspect of the forewing is indeed like that of the large winter forms of *Hadjina viscosa*, or like *Hadjina palaestinensis*, but the hindwings are not paler in the male sex as in those two species, and the body is much robuster than in even the largest *viscosa*. The hindwing of *coptica* is yellow-brown, darker terminad, with darker nervures and without a discal spot on the upper side; its fringes are yellow-brown, sometimes paler between nervures 1 and 2. On the under-

sides, there is a clear dark postmedian line on both wings, a clear cell-spot only on the hindwing.

Antenna, ♂, setose-ciliate; ♀, setose.

Span : 32-35 mm.

Holo-Type : ♀, (fig. 34), 29.xi.19, near Alexandria, in coll. A.

Allo-Type : ♂, (fig. 35), 1.xii.33, Deirout (Delta), in coll. A.

Para-Type : ♂, 1.xii.33, Deirout, in coll. E.P.W.; three ♀♀, 5.xi.15, Maadi, near Cairo and bred at Giza near Cairo on 24.xi.24 (M.); one ♀, labelled only « Prep. WP. 3 », probably taken near Alexandria, in coll. Petroff.

I have not yet examined genitalia of Indian or South African *capensis* nor the types of Walker's many names which Warren-Seitz sinks as synonyms. An eventual revision of world *Hadjina*, *Prospalta* and *Perigea* species, therefore, may result in further changes.

148a. *Caradrina* (*Hymenodrina*) *soudanensis* Hamps.

31.i.33, Wadi Garara, South-East Egypt (M.). An Eremic species ranging from North Africa to South Persia.

148b. *Caradrina* (*Hymenodrina*) *ingrata* Stgr.

One ♀, 31.i.33, Wadi Aideb, Gebel Elba (M.). This species was also recorded by Andres-Seitz from the Maroiut. It is a widespread Mediterranean species, evidently rare, though widespread in Egypt. The specimen has an ill-defined black apical patch on the fore-wing underside, but does not correspond to Rebel's description of the following.

150a. *Caradrina apicimaculata* Rebel (1948).

I can find nothing in Cairo to correspond with this description, which in any case does not make sense to me; if the dimensions are as small as Rebel describes, the resemblance to *quadripunctata* F. (i.e. *clavipalpis* Scop.), on which Rebel insists at some length, does not exist.

152a. *Caradrina* (*Paradrina*) *scotoptera* Pung.

Two ♂♂; 19.xi.32, Minieh, Upper Egypt, Nile valley, and x.23, Suez (M.); also one of the ♀♀ (E.P.W.), Cairo, xi.46, previously identified as *aspersa* (but not that illustrated as *aspersa*), proves to be this little species, previously known from Palestine and Persia. It is an oasis species, and the form from the extreme South (Minieh) is paler and more clearly marked than the others which are more typical. One of the males was inexplicably labelled « *mairei* Draudt » (? det. Andres), but an examination of their genitalia has made their identity sure as above.

168a. *Timora albida* Hamps.

One, 16.i.33, (leg. Priesner), Wadi Garara, South-East Egypt. A North African and Arabian Eremic species.

(180. *Eublemma tomentalis* Rebel (1948)).

The widespread *Porphyria* No. 180 above agrees well with this description, especially its Gebel Elba form, and the genitalia shewn in fig. 39 therefore may be fairly safely assumed to be those of Rebel's species. One specimen from Wadi Tih (Eastern Desert), with identical genitalia, is broader-winged and more ochreous but has the characteristic black scales and dusty appearance of the others.

180a. *Eublemma amygdrosana* Rebel (1948).

I could find nothing to correspond to this description.

184a. *Ozarba fuscescens* Rebel (1948).

A long series (M.) from the Gebel Elba district (Wadi Aideb, 31.i.-3.ii.33; Wadi Canisrob, 24-26.i.33, leg. Priesner) agrees with the description referred to above, and the genitalia are shewn herewith, in Fig. 65. Some specimens are paler brown and these have a dark brown antemedian

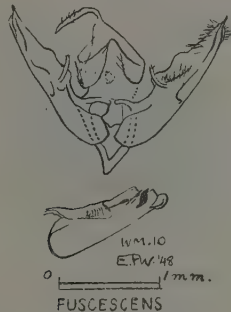


Fig. 65 : *Ozarba fuscescens* Rebel (1948), male genitalia, ventral open view, with aedeagus separated.

line followed by a dark brown median shade between the cell and the inner margin; in these the pale double postmedian line is very distinct, inwardly angled on nervure 1, and broadening on the inner margin as on the costa.

184b. *Ozarba capreolana* Rebel (1948).

I could not find in Cairo a specimen corresponding to this description.

(190. *Tarache biskrensis* Ob. (= *grisescens* Rebel, 1948).

A long and variable series (M.) from the Gebel Elba district, including a male exactly corresponding in locality, date, and markings with Rebel's description. On examining its genitalia I found them, as expected, identical with those of the species of which I illustrated two forms and the male genitalia in last year's Bulletin (the two forms in Figs. 9 and 10 of the Plate) under the name *biskrensis* Ob., which I still believe to be correct. This male

comes in markings, between the two forms there shewn. Even as a form Rebel's (1948) name must yield to the earlier *orientalis* Brandt. This name however can only be used for some Egyptian forms, not for the race as a whole.

190a. *Tarache seminigra* Rebel (1948).

I could not find in Cairo anything corresponding to this description.

193a. *Tarache carnescens* Hamps.

I am indebted to Dr. E. Berio for identifying this specimen from a photograph and my drawing of the genitalia. These parts are shewn in Fig. 66 for comparison with the other *Tarache* genitalia illustrated in last year's Bul-

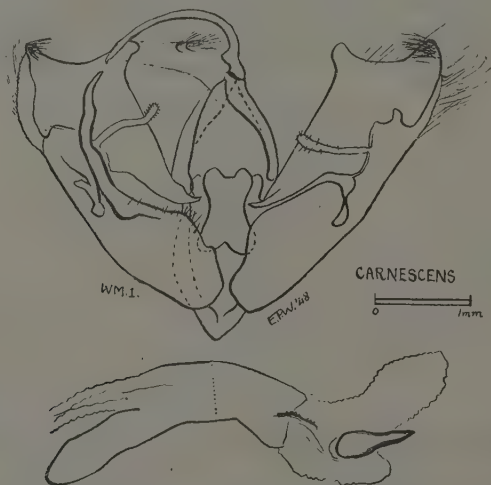


Fig. 66 : *Tarache carnescens* Hamps., male genitalia, ventral open view, with aedeagus separated.

letin. A Tropical East African species, only known in Egypt in the Gehel Elba region ; 24.i.33, Wadi Canisrob (leg. Priesner) (M.).

204a. *Ulotrichopus tinctipennis* Hamps.

22.ii.38, Wadi Abraq, Gebel Elba (M.). Tropical African.

206a. *Catocala lesbia* Christ.

15.ix.41, Wadi el Lega, South Sinai (E.). Eastern Eremic.

206b. *Catocala puerpera syriaca* Schulz.

15.ix.41, Wadi el Lega, South Sinai (E.). Euroriental.

(213a. *Sphingomorpha chlorea* Gr.).

24.iv.41, Wadi el Rabaa, South Sinai (E.). Also from the Gebel Elba district (M.).

213b. *Achaea catella* Guenée.

Gebel Elba district (M.). A Tropical species.

228a. *Pyraloides spodia* Rebel (1948).

228b. *Pseudocalpe anubis* Rebel (1948).

I can find nothing in Cairo corresponding to these two descriptions, though the latter may perhaps prove synonymous with No. 228 in my list.

230a. *Anumeta* spec.

One, v.35, Wadi Assiuti, Upper Egypt (M.), a comparatively small species. The same collection contains another form of *Anumeta* of the same size, but with darker markings, which may be distinct. I regret that these one or two new species (for Egypt) cannot be certainly named yet. Perhaps I will be able to report further about them in Part II.



Fig. 67 : *Rhynchodontodes sagittalis* Rebel (1948), ♀.

233a. *Armada panaceorum* Men.

5.iv.24, Wadi Somghi, North Sinai (M.). Pan-Eremic.

(234. *Armada dentata* Stgr.).

This species was bred from larvae found on *Heliotropium luteum* in the desert at Kerdasa (Abu Rawash), i.e. near Giza, near Cairo. Date: 15.vii.34 (M.). A skin has been preserved which permits the larva, hitherto undescribed, to be made known, as follows. About one inch long, whitish grey, somite 6 lacking a pair of claspers. Somites 7, 8, 9, and 12 have well-developed clasper-pairs. Setae, black. Transverse black dorsal bars, complete on somites 4 and 5, interrupted and obsolescent on subsequent somites. Longitudinal blackish stripes, more or less developed. Spiracles, brown, black-rimmed. Head, whitish, black-dotted. Thoracic feet and abdominal claspers, pale.

(238. *Acrobyla kneuckeri* Rebel).

A fine series from the Gebel Elba district (M.), including large richly marked specimens. Also single specimens from Mersa Halaib and Wadi Assiuti (Upper Egypt) (M.).

241a. *Rhynchodontodes sagittalis* Rebel (1948) (Fig. 67).

There is a female in coll. A., taken by Mohamed Tewfik Effendi at Gebel Elba in spring 1928, which corresponds to this description, and it is illustrated herewith.

242a. *Hypena obsitalis* Hubn.

One, 3.viii.43, Wadi el Lega, South Sinai (E.).

This Mediterranean species also occurs South of the Tropic in South-West Arabia.

243a. *Orgyia ochrodorsalis* Rebel (1948).

This was described from Wadi Chab, near Gebel Elba, but I can find nothing corresponding to the description in the Cairo collections.

244a. *Albarřacina* (?) *hawi* Standf.

One, 3.viii.43, Wadi el Lega, South Sinai (E.).

246a. *Polymona rubescens* Rebel (1943) (Fig. 68).

I have found three ♀♀ (M.) corresponding to this description of a *Lymantriid* from the Gebel Elba region. One of these is illustrated. I can express no opinion at present on the generic attribution or the validity of this name.

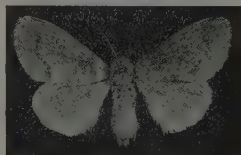


Fig. 68 : *Polymona rubescens* Rebel (1948), ♀.

TWO MORE DELETIONS

I have now seen the « *Scotogramma sodae* » of Storey and they are merely *C. albipicta* Chr. (No. 94) so the name *sodae* can be deleted from the Egyptian list. Probably the same applies to the « *Cardepiā irrisor* » of Rebel.

I have now also seen the « *Porphyrinia suppura* » of Storey and they are merely pale *P. ostrina* forms (No. 173). The name *suppura* can therefore likewise be deleted from the Egyptian list.

PLATES I-VII

Explanation of Plate I

Fig. 1 : *Iolana alfierii* spec. nov., ♂. — Fig. 2 : *Iolana alfierii* spec. nov., ♂, underside. — Fig. 3 : *Lambessa pungeleri* Stertz., ♂. — Fig. 4 : *Lambessa decolorata* Klug, ♂. — Fig. 5 : *Lambessa decolorata* Klug, ♀. — Fig. 6 : *Dendrolimus alfierii* Andres-Seitz, ♂. — Fig. 7 : *Dendrolimus alfierii* Andres-Seitz, ♀. — Fig. 8 : *Dendrolimus alfierii* Andres-Seitz, larva. — Fig. 9 : *Agrotis herzogii* Rebel, ♂. — Fig. 10 : *Agrotis sardzeana* Brandt, ♀. — Fig. 11 : *Autophila pauli* Boursin, ♂. — Fig. 12 : *Autophila cymaenotaenia orthotaenia* Wils., ♂. — Fig. 13 : *Pseudamathes volloni* Lucas, ♀. — Fig. 14 : *Leucanitis picta radapicta* Strg., ♀. — Fig. 15 : *Syneda habibazel* Dumont, ♂. — [Natural size].



Actual Size

Bull. Soc. Fouad 1^{re} Entom., XXXII, 1948.

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Fig. 1 : Nile valley scene at Giza near Cairo. Roadside trees are exotics (*Eucalyptus*), other tree is *Acacia nilotica*. Irrigated fields with date-palm (*Phœnix*) in middle background; in far background the Pyramids are seen standing on the sandy cliffs of the Libyan Desert bordering the Nile valley in the West [photo E. P. Wiltshire].



Fig. 2 : Wadi Digla , Eastern or Arabian desert [photo A. Alfieri].

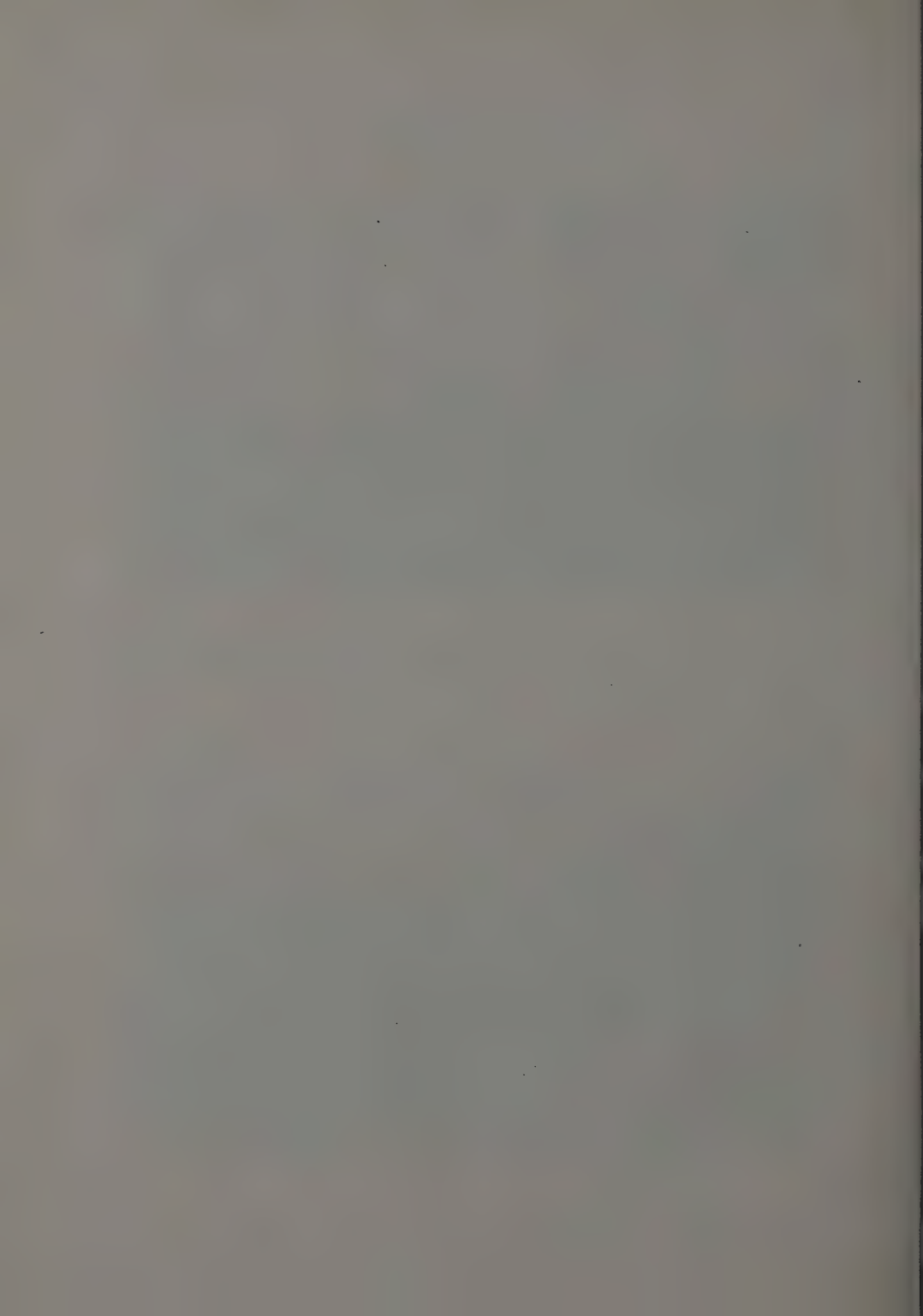




Fig. 1 : Spring flowers in the Mariout steppe at Burg, with unirrigated fig-plantation [photo Prof. Oliver].



Fig. 2 : Spring flowers in the Mariout steppe at Ikingi, with unirrigated barley, and in background an oasis of *Acacia nilotica* and *Tamarix* (irrigated with brackish water) [photo E. P. Wiltshire].

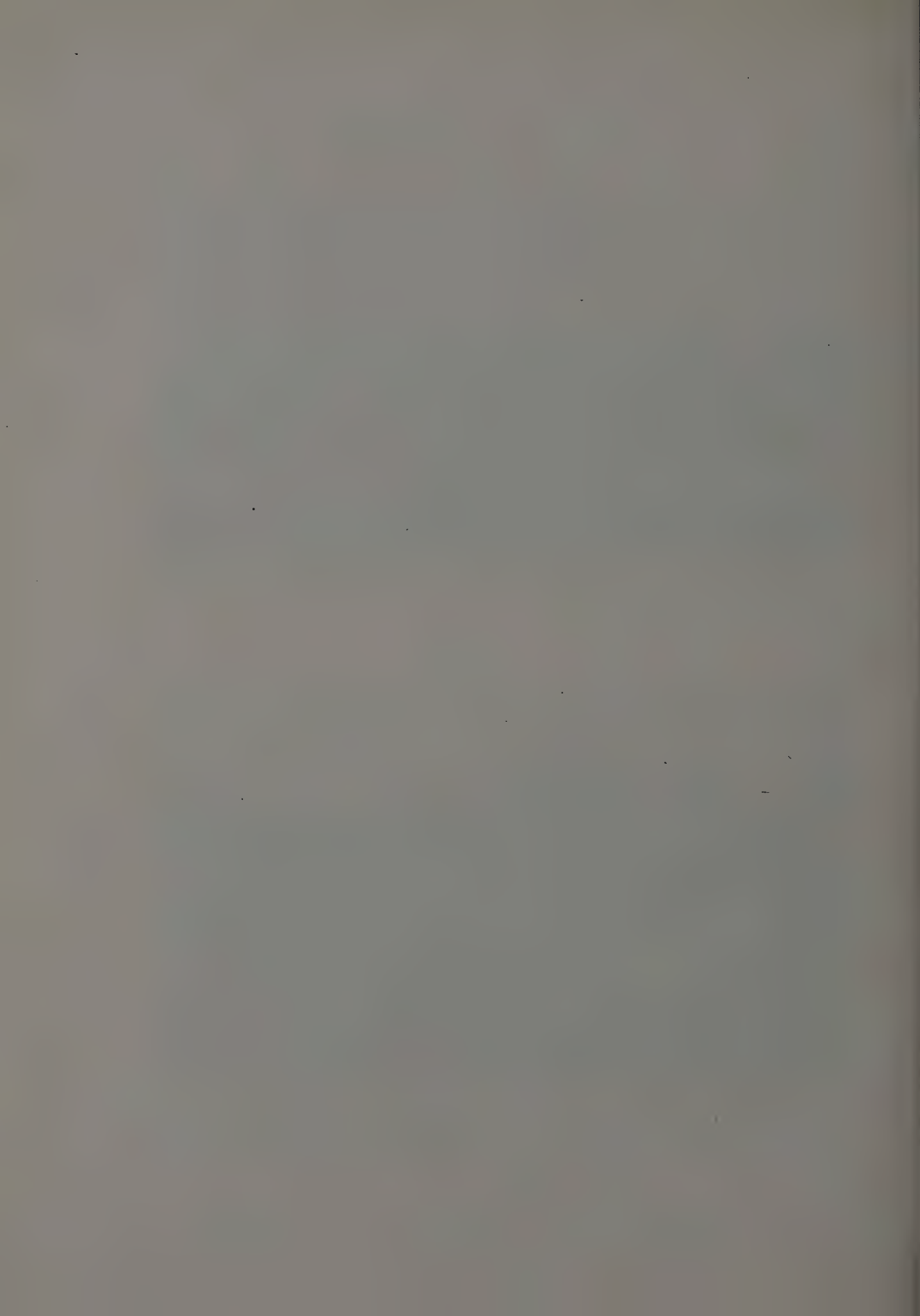




Fig. 1 : Bahariya Oasis, in Libyan Desert; the water is brackish [photo A. Alfieri].



Fig. 2 : Wadi Isla, at 1000 m., South Sinai [photo A. Alfieri].



Fig. 1 : Steppe near Gebel Katherina, South Sinai [photo A. Alfieri].



Fig. 2 : Characteristic scenery of Gebel Elba district; in foreground is an *Acacia* woodland [photo J. Shabetai].

PLATE VI

Explanation of Plate VI

Figs. 1 and 2 : *Anadiasa undata* Klug, larvae. — Fig. 3 : *Nadiasa acaciae* Klug, larva. — Fig. 4 : *Nadiasa acaciae* Klug, eggs, cocoon, and moth (♀). — Fig. 5 : *Cucullia efflatouni* spec. nov., ♀. — Fig. 6 : *Antitype juditha* Stgr., ♂. — Fig. 7 : *Bryomima sinaica* spec. nov., ♂. — Fig. 8 : *Sidemia discordans* Boursin, ♂. — Fig. 9 : *Sidemia beduina* spec. nov., ♂. — Fig. 10 : *Bryophila ?paulina* Stgr., ♀. — Fig. 11 : *Caradrina (Hymenodrina) aspersa* Ramb., ♀. — Fig. 12 : *Thalerastria alfierii* spec. nov. ♂. — [Natural size].

The Lepidoptera of the Kingdom of Egypt

E. P. Wiltshire

Plate VI



1



2



3



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4

The Lepidoptera of the Kingdom of Egypt

E. P. Wiltshire

Plate VII



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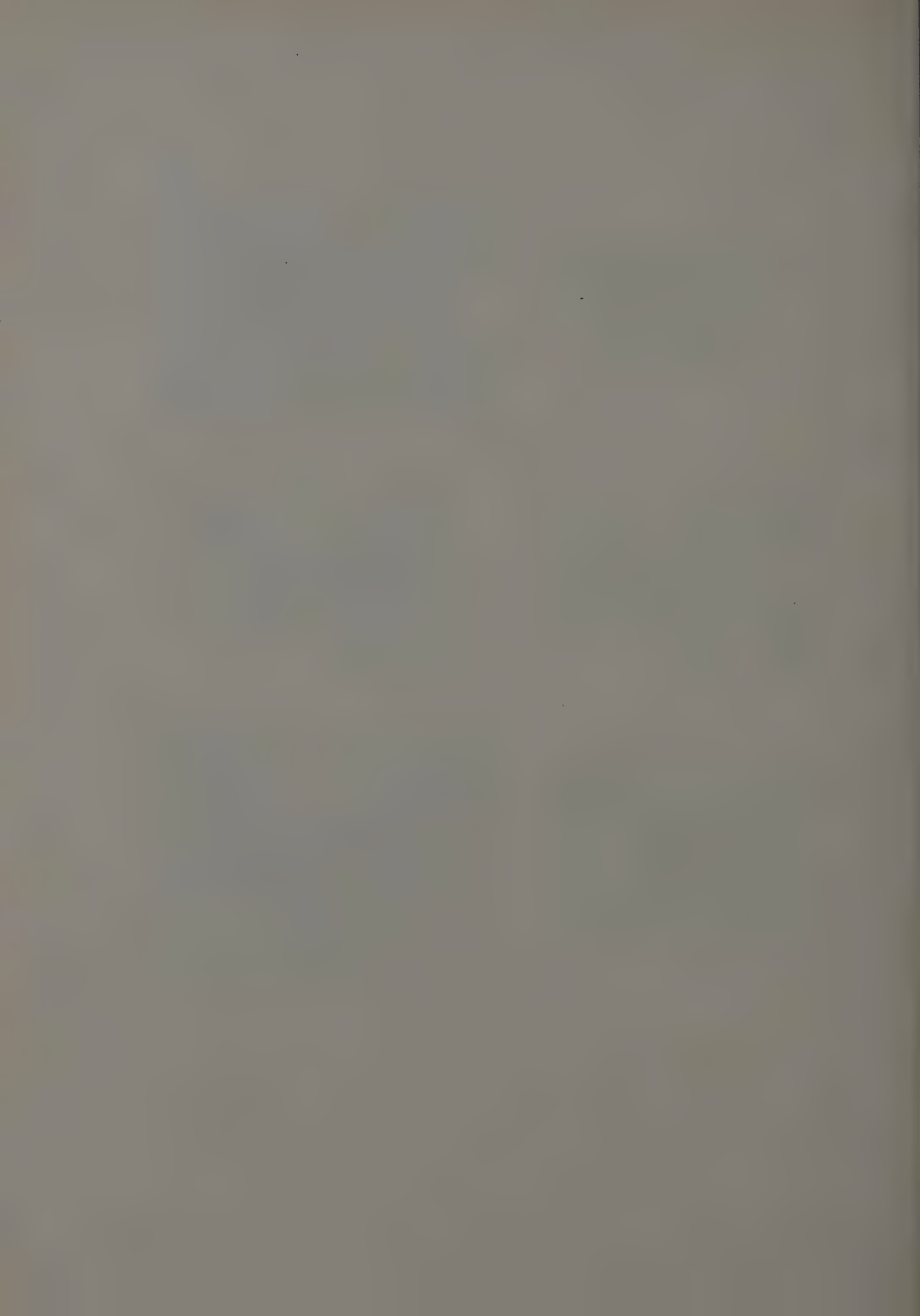


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6

Fig. 1 : *Lasiocampa serrula aegyptiaca* Ob., ♂. — Fig. 2 : *Lasiocampa serrula aegyptiaca* Ob., ♀. — Fig. 3 : *Lasiocampa serrula palaestinensis* Stgr., ♀. — Fig. 4 : *Lasiocampa serrula davidis* Stgr., ♂. — Fig. 5 : *Lasiocampa josua* Stgr., ♂. — Fig. 6 : *Lasiocampa josua* Stgr., ♀. — [Natural size].



Zur Systematik der mediterranen *Tortricodes*-Arten.

[Lepidoptera : Tortricidae]

(mit 16 Abbildungen)

von Dr. H. G. AMSEL, Buchenberg (Baden)

Walsingham beschrieb im *Ent. Monthly Mag.* 1907 auf Seite 194 und 195 3 neue Tortriciden-Arten aus Algerien, die er zur Gattung *Tortricodes* stellte. Diese 3 Arten, *eremica*, *polita* und *chapmanni*, sowie die aus Palästina beschriebene *palmoni* Ams. (*Veröff. Kol. Mus. Bremen*, Bd. 3, p. 37, 1940) sind u.W. die einzigen mediterranen Vertreter dieses sonst durch die nord- und mitteleuropäische *torticella* Hb. und die ostasiatische *ignavana* Chr. und die zentralasiatische *adamana* Kenn. vertretenen Genus.

Da Kennel in seiner Tortriciden-Monographie die Walsingham'schen Arten leider übersehen hat und auch sonst in der Literatur, wie es scheint, nichts mehr über diese wenig bekannten Arten veröffentlicht wurde, andererseits die systematische Stellung, die Walsingham den Tieren gegeben hatte, recht fragwürdig erscheint, wurde nunmehr eine Gelegenheit benutzt, die Untersuchung der Arten durchzuführen. Die Ergebnisse sind folgende :

Die Gattung *Tortricodes* Gn. ist im Geäder durch die Anhangszelle des Vorderflügels ausgezeichnet, in der Fühlerbildung des Männchens durch sehr kurze unterseitige Wimperbüschel am Anfang und Ende jeden Fühlergliedes (fig. 15), im Genitalapparat des Männchens (fig. 3) durch einen sehr kräftigen Gnathos, nach innen gerichtete, gut entwickelte Sacculi und stark gekrümmten Aedaeagus mit einer sehr langen und einer sehr kurzen, dünnen Spitze. Alle diese Eigenschaften besitzen weder *eremica*, noch *polita* (*chapmanni* konnte nur in Bezug auf das Geäder untersucht werden, da nur Weibchen vorlagen) noch auch *palmoni*.

Im Flügelgeäder sind die 3 Walsingham'schen Arten durch das Fehlen der Anhangszelle des Vorderflügels und die Abwesenheit der Teilungsader der Flügelzelle charakterisiert. Alle Adern im Vorderflügel sind vorhanden, im Hinterflügel fehlt m2. Im einzelnen ist zu sagen :

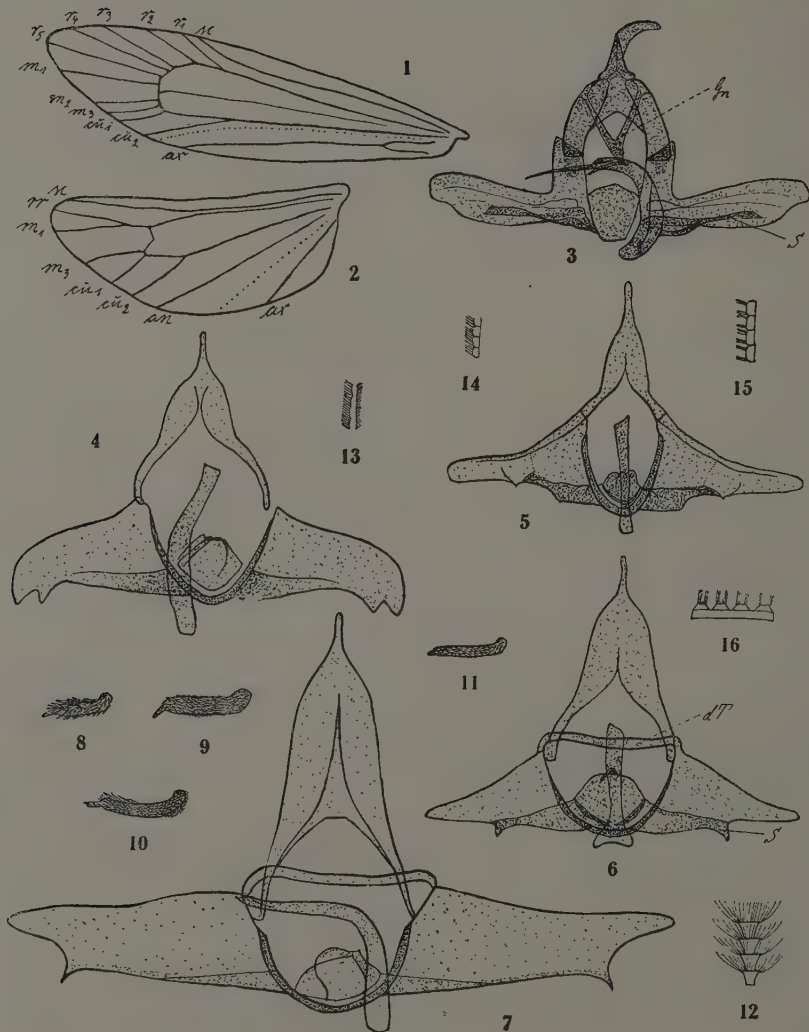


Fig. 1 : Vorderflügel von *Oxypteron palmoni* Ams. — Fig. 2 : Hinterflügel von *Oxypteron palmoni* Ams. — Fig. 3 : Genitalapparat von *Tortricodes tortricella* Hb. (Genital-Untersuchung 227). — Fig. 4 : Genitalapparat von *Oxypteron polita* Wlsm. (Genital-Untersuchung 226). — Fig. 5 : Genitalapparat von *Oxypteron eremica* Wlsm. (Genital-Untersuchung 225). — Fig. 6 : Genitalapparat von *Oxypteron palmoni* Ams. (Genital-Untersuchung 224). — Fig. 7 : Genitalapparat von *Oxypteron impar* Stgr. (Genital-Untersuchung 308). — Fig. 8 : Palpus von *Tortricodes tortricella* Hb. — Fig. 9 : Palpus von *Oxypteron palmoni* Ams. — Fig. 10 : Palpus

von *Oxypteron polita* Wlsm. — Fig. 11 : Palpus von *Oxypteron eremica* Wlsm. — Fig. 12 : Fühlerglieder (von unten) von *Oxypteron palmoni* Ams. — Fig. 13 : Fühlerglieder (von unten) von *Oxypteron polita* Wlsm. — Fig. 14 : Fühlerglieder (in Seitenansicht) von *Oxypteron polita* Wlsm. — Fig. 15 : Fühlerglieder (in Seitenansicht) von *Tortricodes tortricella* Hb. — Fig. 16 : Fühlerglieder (in Seitenansicht) (mittlerer Fühlerteil) von *Oxypteron impar* Stgr.

Bei *polita* ist der Abstand von r1 zu r2 kleiner als der von r2 zu r3. Bei *chapmanni* ist r2 näher an r3 als an r1 und bei *eremica* ist der Abstand von r1 zu r2 doppelt so gross wie von r2 zu r3. Es bestehen also deutliche Unterschiede im Verlauf dieser 3 Adern bei allen 3 Arten, indessen ist das Grundprinzip übereinstimmend mit dem der Gattung *Oxypteron* Stgr., wie es Kennel in seiner Monographie auf Taf. I, fig. 25a abbildet.

Bei *palmoni* kommt als einziger Unterschied gegenüber den Walsingham'schen Arten das Vorhandensein der Teilungsader der Vorderflügel-Zelle hinzu (fig. 1), doch bedeutet dies wenig, da die Walsingham'schen Arten an dieser Stelle deutlich eine Falte zeigen. Im Hfgl. freilich weichen alle Arten von *Oxypteron* durch gestielte rr und m1 ab, was aber auch von untergeordneter Bedeutung ist.

Die Fühlerbildung ist bei allen Arten recht bemerkenswert : Bei *tortricella* (fig. 15) stehen am Anfang und Ende jeden Fühlergliedes unterseits sehr kurze Wimperbüschel, deren Länge ungefähr der Breite der Fühlerglieder entspricht. Bei *polita* (fig. 13 und 14) sind die einzelnen, schwach gegeneinander abgesetzten Fühlerglieder unterseits gleichmässig kurz zweireihig bewimpert, wobei die Länge der Wimpern auch hier mit der Fühlergliedbreite übereinstimmt. Das gleiche trifft für *eremica* zu. (*chapmanni* konnte mangels männlicher Stücke nicht untersucht werden). Bei *palmoni* (fig. 12) dagegen sind die Fühlerglieder stark gegeneinander abgesetzt und die Enden der Glieder tragen unterseits einen Halbkreis sehr dünner Wimpern, die ungefähr doppelt so lang wie die Glieder breit sind. Hier liegt also ein ganz abweichendes Bauprinzip vor. Bei *impar* Stgr. (fig. 16 Seitenansicht von 4 Fühlergliedern des mittleren Fühlerteils) stehen unterseits am Anfang und Ende jeden Fühlergliedes Wimperbüschel, deren Länge mit der Fühlergliedbreite übereinstimmt.

Im Genitalapparat des Männchens sind alle genannten Arten gegenüber *tortricella* durch das Fehlen des Gnathos, die nicht nach innen gerichteten Sacculi und einen Aedaeagus ausgezeichnet, der nicht in Spitzen ausläuft, sondern stumpf abgeschnitten ist (fig. 3-7). *Palmoni* und *impar* sind gegenüber *eremica* und *polita* durch den deutlich geschlossenen Tegumenring (Fultura superior) ausgezeichnet, der hier normal chitinisiert ist, während er bei *polita* und *eremica* mangels Chitinisierung zu fehlen scheint (wie übrigens auch bei *tortricella*). Auf der Abbildung ist dieser dorsale Teil des Tegumenringes als dT bezeichnet.

Die Palpenbildung (fig. 8-11) ist bei *tortricella* dadurch auffallend, dass der Palpus stark abstehend beschuppt ist und das Endglied nur wenig heraustritt. Bei *palmoni* und *impar* ist der Palpus fast anliegend beschuppt, ebenso bei *eremica*, wo das Endglied in den Schuppen des 2. Gliedes fast ganz versteckt ist. Bei *polita* ist das Mittelglied am Ende etwas abstehend beschuppt.

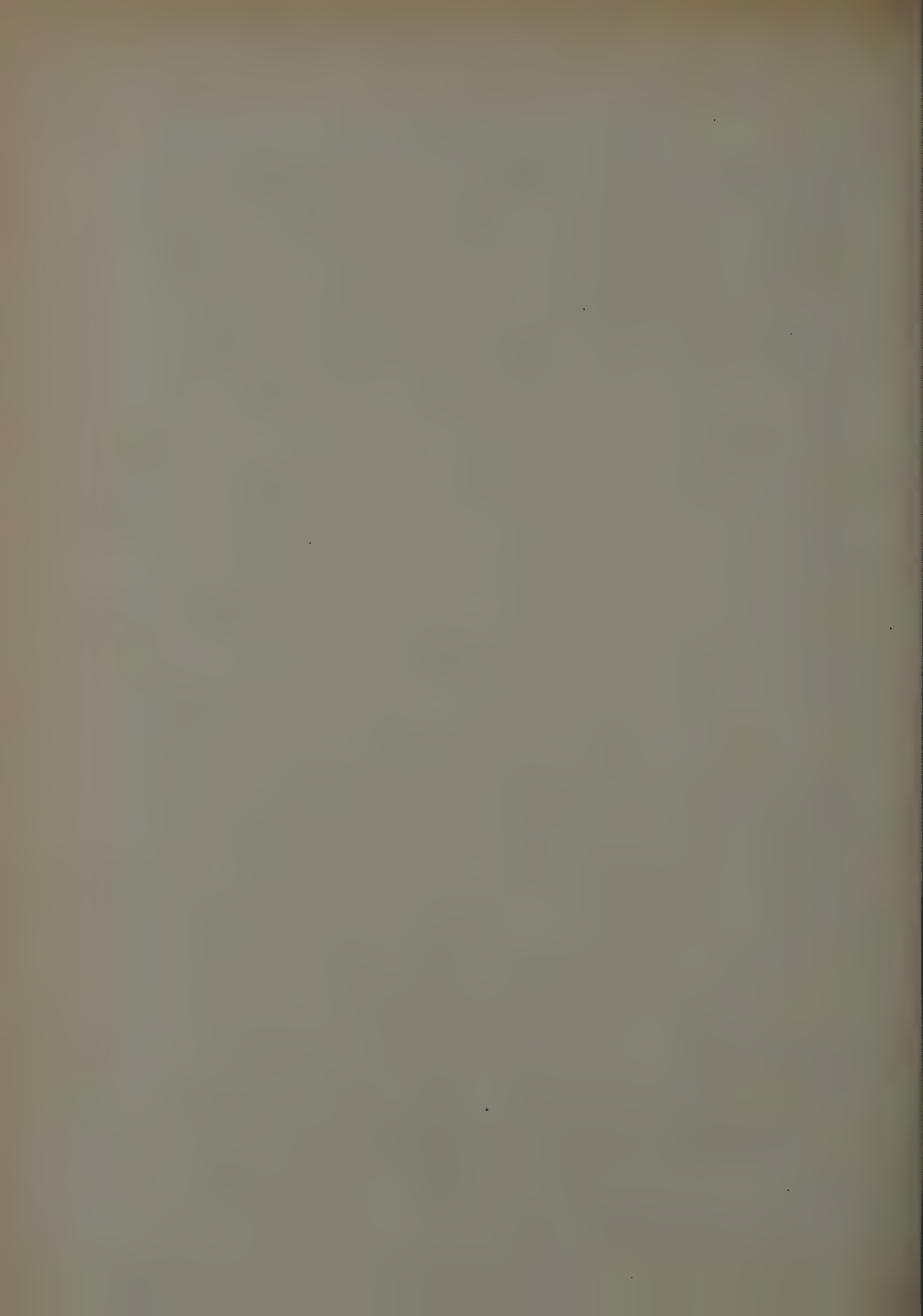
Demnach ergeben sich folgende Gesamtergebnisse: *palmoni* Ams. und die 3 Walsingham'schen Arten *eremica*, *polita* und *chapmanni* gehören nicht in die Gattung *Tortricodes*, sondern zu *Oxypteron*. Innerhalb dieser Gattung stehen sich *impar* und *palmoni* wegen der bei beiden Arten vorhandenen Fultura superior und der sonstigen grossen Ähnlichkeiten des Genitalapparates am nächsten. In der Fühlerbildung dagegen weicht *palmoni* von allen Arten am meisten ab. Zu *chapmanni* ist zu sagen, dass diese Art wie die Originalbeschreibung sowohl wie auch 2 vorliegende Weibchen der Walsingham-Sammlung einwandfrei erkennen lassen, identisch mit *Cnephasia exigua* Lah. ist, die in der Kennel'schen Monographie sehr gut abgebildet ist. Der Laharpe'sche Name hat die Priorität. Zu diesen Arten kommt noch die von Chrétien beschriebene *O. partitanum* (Ann. Soc. Ent. Fr., 1915, p. 297), die mir leider in Natur unbekannt geblieben ist. Da der Autor weder über die Fühlerbildung noch über den Genitalapparat Angaben macht, bleibt die Stellung der Art zunächst noch offen. Die auffällige, von den anderen Arten stark abweichende Zeichnung scheint jedenfalls auf eine recht eigenartige Stellung des Tieres hinzuweisen.

Bezüglich der Deutung des Hinterflügel-Geäders von *Oxypteron* und *Tortricodes*, sei noch hervorgehoben, dass die Kennel'sche Auffassung wohl nicht richtig ist. Kennel schreibt im Spuler und in seiner Monographie, dass bei *Tortricodes* und *Oxypteron* m3 und cu1 zusammenfallen. Es fallen aber nicht diese beiden Adern zusammen, sondern m2 fehlt. Dies wird an *polita* deutlich, wo die Ader m2 als Falte noch sehr gut sichtbar ist. Demgemäss sind bei der Beschriftung der Adern die entsprechenden Benennungen eingesetzt.

Als Abschluss folge eine Bestimmunbstabelle der paläarktischen *Oxypteron*-Arten mit Angabe der bisher bekanntgewordenen Vorkommen:

1. Vorderflügel mit dunkler Längslinie aus der Wurzel bis zur Flügelspitze (Tunis: Gafsa) *partitanum* Chrét.
- Vorderflügel ohne solche dunkle Längslinie 2
2. Grössere Arten mit mindestens 16 mm Spannweite 3
- Kleinere Arten. Spannweite höchstens 15 mm 4
3. Vfgl. mit hellem Costalstreif bis 3/5 Costalänge (Algerien) *polita* Wlsm.
- Vfgl. ohne Aufhellung der Costa 5

4. Kleinere Art von 11-13 mm Spannweite. Vgl. fast ohne schwärzliche Schuppen, Hinterflügel sehr hell (Algerien) *eremica* Wlsm.
— Grössere Art, wenigstens die Männchen von 14 mm Flügelspannung. Vorderflügel mit zahlreicheren schwarzen Schuppen. Hinterflügel grau (= *chapmanni* Wlsm.; Sizilien, Algerien) *exiguana* Lah.
5. Wimperbüschel der Fühler ebenso lang wie die Fühler breit. Spannweite 18-20 mm. (Sarepta, Transkaukasien, Irak) *impar* Stgr.
— Wimperbüschel der Fühler doppelt so lang wie der Fühler breit. Spannweite 20-23 mm. (See Genezareth) *palmoni* Ams.
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2
The Morphology and Anatomy
of *Coccinella*
undecimpunctata aegyptiaca Reiche

[Coleoptera-Coccinellidae]

(with 36 Text-Figures)

by M. M. IBRAHIM, B.Sc. (College of Agriculture, Giza),

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INTRODUCTION

Coccinella undecimpunctata L. is the commonest ladybird beetle known in Egypt. It is an extremely important predator of many species of Aphids. This paper deals with the morphology and anatomy of this beneficial insect.

The Author wishes to thank Dr. A. A. Moursi, Senior Entomologist, for help, criticism and suggestions. He is also very much indebted to Mr. A. Alfieri and M. Hafez Eff.

Coccinella undecimpunctata L. has been described in 1758 (*Systema Naturae*). *Coccinella triangularis* Thunbg. described in 1795 (*Fauna Suecica*, IX) is but a synonym of the previous.

The species, however, shows considerable variations and exists in more than one race, variety and aberration. These races differ as to the form of the cream white patches on the sides of the prothorax. The Egyptian race, *aegyptiaca*, which was described by Reiche (1861) differs from the typical *undecimpunctata* by the posterior extension of the two cream white patches on the sides of the prothorax. Furthermore, in common with the typical form, the Egyptian race occurs in several aberrations. Over ten of these aberrations are already recognised in Egypt, depending upon the number and the way by which the different black dots of the elytra are united.

GENERAL MORPHOLOGY

The Head

The head (fig. 1) is almost rectangular in shape; it measures about 0.6 mm. in length and 1.0 mm. in width. It is strongly sclerotized; and with the exception of two triangular cream white patches which occur on the dorsal surface between the compound eyes, it is metallic black in colour. The head is covered with very short black hairs which appear whitish due to light reflections.

The compound eyes are more or less hemispherical and are located at the anterior corners of the head. They are dark brown in colour except for a small cream white spot at the anterior end. On the ventral surface of the head (fig. 2), the gula appears as trapezoidal structure separating the base of the labium from the occipital foramen; and the gular sutures run anteriorly on both sides. The genae are well developed and form the greater part of the sides of the head.

The antennae arise from the anterior corners of the head, immediately in front of the compound eyes. They are club-shaped and eleven segmented with the scape strikingly much darker than any of the other segments.

The Mouth Parts

The mouth parts (figs. 1 and 2) consist of the following :

The labrum (fig. 1) is a more or less rectangular plate which is movable and articulated with the head. Its upper surface is covered with comparatively dense long hairs.

The mandibles (figs. 2 and 3) are two solid compact pieces on the sides of the preoral cavity. Each is articulated with the head by means of a convex process which fits accurately in a small groove at the base of the gena. The mandibles are moved by two powerful sets of abductor and adductor muscles. Each mandible is bidentated distally and carries on its inner margin a flexible very finely serrated plate.

The maxillae are attached to the head posterior to the mandibles. Each consists of a quadrate cardo which is attached to the head by a trifurcate base (fig. 4). The stipes is a triangular structure carrying a triangular plate on its outer surface, the palpifer, and a similar plate on its inner surface, the subgalea. The palpifer carries the four segmented maxillary palp. This is a well developed organ, its distal segment is funnel shaped and much larger than the others. At its distal end the stipes carries two lobes, the galea and the lacinia. The galea is two segmented and is fringed distally by a dense row of spines, while its distal half is covered with short hairs. The lacinia is blade like and in common with the galea, it is also fringed along its inner border by a row of spines.

The labium is a longitudinal structure which forms the floor of the preoral cavity. The trapezoidal submentum and the more or less quadrate mentum are heavily sclerotized and are separated by a narrow suture. The sides of the distal border of the mentum are provided with three long spines each.

The prementum, on the other hand, while membranous and light coloured proximally, is dark and heavily sclerotized at its distal end. It carries two three segmented comparatively short labial palpi and a densely hair covered ligula. The latter organ is an entire structure with no distinct lobes.

The head is connected with the thorax by a very narrow light coloured flexible neck.

The Thorax

The prothorax is the largest of the thoracic segments and is freely movable. It is rectangular in shape, concave at its anterior end and convex posteriorly. The prothorax is metallic black in colour except for two creamy white patches on its sides. These patches present a wide variation in form (Weise, 1892).

They are quadrangular at their distal halves and are prolonged into two narrow bands to the posterior corners of the segment (fig. 5). Very rarely, however, they are continued as a very narrow band at the anterior border of the prothorax.

The pronotum consists of a single undivided shield while the sternum and the pleuron are fused to form a sternopleural complex. The surface of the pronotum is punctured and from the base of each puncture arises a very small articulated hair. Ventrally, the prothorax (fig. 6) is separated from the mesothorax by a comparatively very broad cream white flexible band. This band is evident only when the head and prothorax are bent upward or flattened. Normally, however, the head and prothorax are bent downward and the band is not evident on the ventral surface. This band seems to be a part of the mesothorax since it stretches far beyond the anterior coxal cavities and contains the anterior pair of spiracles.

The mesothorax is again metallic black in colour except for the mesosternum episternum which is cream white in colour. The openings of the second pair of spiracles are located on both sides of the mesothorax in a flexible folded membrane between the tergum and the mesosternum episternum. The presence of these spiracles in these positions is probably due to migrations from the segment behind. The metasternum is very well developed and is partially divided into two plates by a median groove.

The Wings

The elytra (fig. 7) are convex, almost hemispherical, provided with very fine hairs, and cover the upper side of the body. In newly emerged insects

the elytra are yellowish in colour without any black dots which appear only a short time later. When the insect gets older the elytra turn reddish.

Each elytron is provided with five black more or less rounded dots together with one other half dot at its anterior inner end which makes with the other half dot on the other elytron a common dot.

The wings (fig. 8) are membranous and triangular in shape, slightly more than 1 1/2 time the length of the body and are densely covered with short hairs. The basal half, except for the orange red wing veins, is transparent white while the distal half is suffused with brown. At rest the wings lie under the elytra with their distal halves folded twice beneath the basal halves.

The Legs

The legs (fig. 9) are adapted for walking and are similar in both sexes. The anterior ones are smaller than the median and the posterior respectively. The coxae vary in shape and size according to the legs to which they belong. While those of the first pair are uneven, those of the second pair are triangular and those of the third pair are rectangular (figs. 10, 11 and 12).

The trochanter is rigidly fixed to the femur which is the largest segment of the leg. The tibia is elongate and bristly; distal end of median and hind tibiae carrying a pair of short spurs. The tarsus (fig. 13) is four segmented; the metatarsus is the widest though not the longest segment; it is triangular in shape and is fringed internally with very dense hairs. The second segment is flattened and more or less triangular; its outer surface is concave throughout its greater part; it is also fringed internally with dense hairs. The third segment is the smallest and is cylindrical in shape. The fourth segment is the longest and is beset with comparatively dense spines. The pretarsus is small and carries two curved claws at its distal end. All the legs are black in colour.

The Abdomen

The abdomen (figs. 14 and 15) consists of eight visible segments; the sterna of the first two are comparatively not well developed. While the terga and sterna are in the form of undivided sclerotized shields, the pleura are flexible and membranous. The abdominal spiracles lie in the pleura of the first five segments. The eighth abdominal segment is of special interest, its tergum and sternum varying in shape according to the sex of the insect. Thus, while the posterior margin of the tergum is rounded in the male, it is more or less acute in the female. The posterior margin of the sternum is concave in the male and convex in the female (fig. 16).

Within the eighth male abdominal segment is an invagination which contains the reduced ninth and tenth segments as well as a large genital

chamber which is provided with the external genitalia. The anus opens in this invagination between the ninth and tenth terga.

In the female the ninth segment is represented by the tergum only. The gonopore opens within the invagination of the eighth segment. In the male this segment is represented by the tergum and by a narrow elongated scle

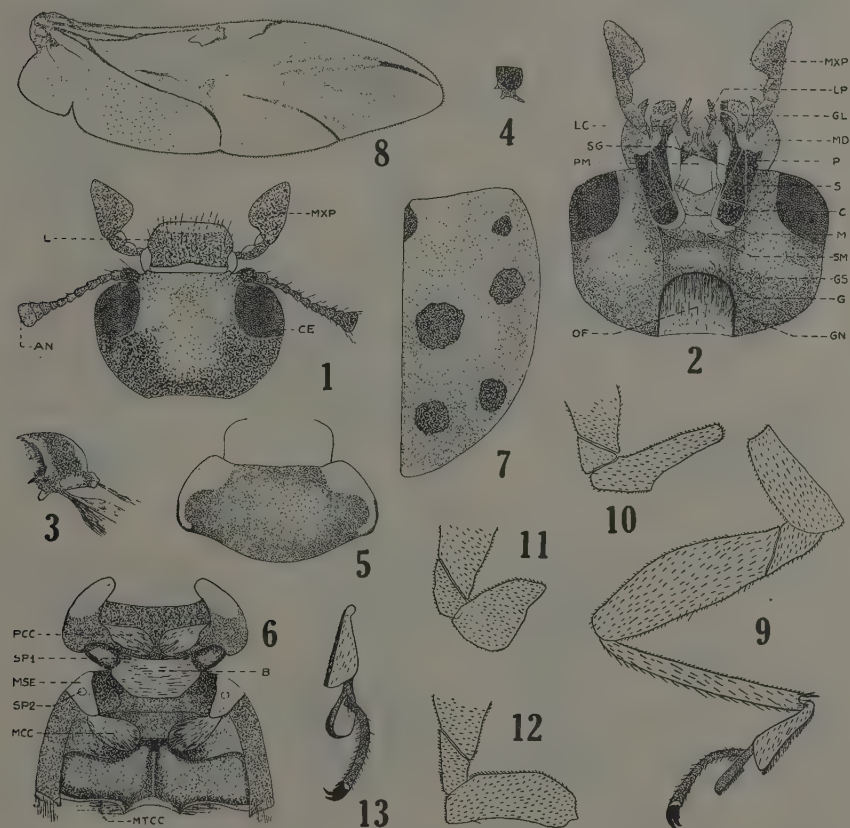


Fig. 1 : Head, dorsal view (AN, antenna; CE, compound eye; L, labrum; MXP, maxillary palp). — Fig. 2 : Head, ventral view (C, cardo; G, gula; GL, galea; GN, gena; GS, gular suture; LC, lacinia; LP, labial palp; M, mentum; MD, mandible; MXP, maxillary palp; OF, occipital foramen; P, palpifer; PM, prementum; S, stipes; SG, subgalea; SM, submentum). — Fig. 3 : Mandible showing abductor and adductor muscles. — Fig. 4 : Base of cardo. — Fig. 5 : Prothorax, dorsal view, showing white patches on its sides. — Fig. 6 : Thorax, ventral view (B, band separating pro- and mesothorax; MCC, median coxal cavity; MSE, mesosternum episternum; MTCC, metacoxal cavity; PCC, procoxal cavity; SP1 and SP2, thoracic spiracles). — Fig. 7 : Elytron. — Fig. 8 : Wing. — Fig. 9 : Hind leg. — Fig. 10 : Basal part of foreleg. — Fig. 11 : Basal part of middle leg. — Fig. 12 : Basal part of hind leg. — Fig. 13 : Tarsal segments and pretarsus.

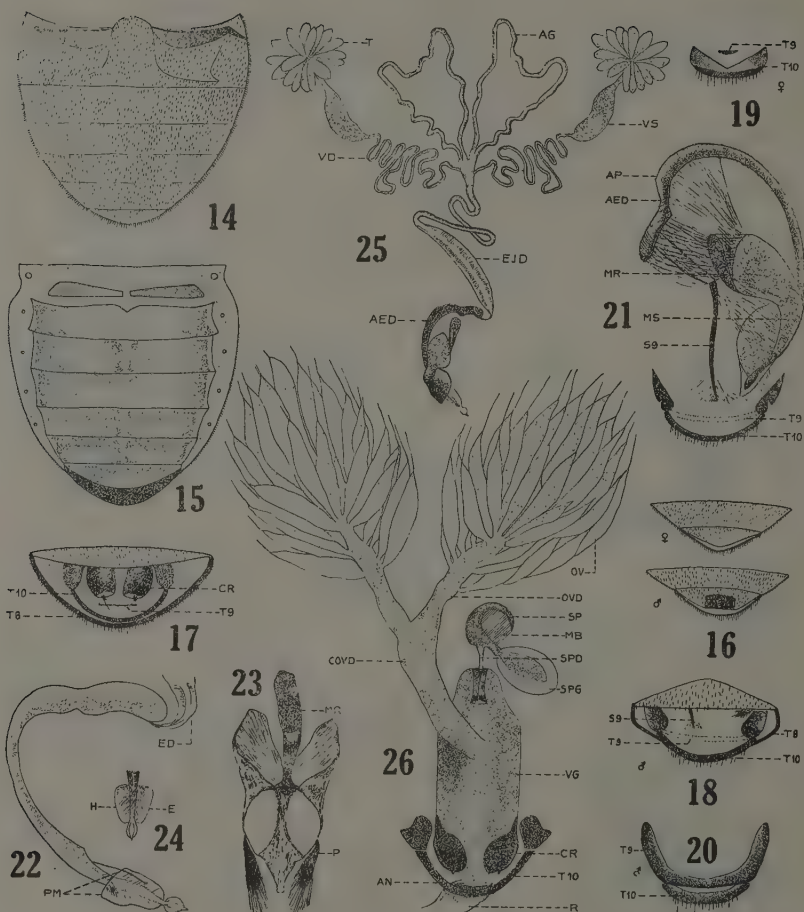


Fig. 14 : Abdomen, ventral view. — Fig. 15 : Abdomen, dorsal view. — Fig. 16 : Posterior extremity of adult, ventral view (upper female, lower male). — Fig. 17 : Posterior extremity of female abdomen, last sternum removed (CR, chitinised rod; T8, T9, T10, eighth, ninth, and tenth abdominal terga). — Fig. 18 : Posterior extremity of male abdomen, last sternum removed (S9, ninth sternum; T8, T9, T10, eighth, ninth and tenth abdominal terga). — Fig. 19 : Ninth and tenth terga in female. — Fig. 20 : Ninth and tenth terga in male. — Fig. 21 : Male genitalia (AED, aedeagus; AP, aedeagal pouch; MR, middle rod; MS, median sac; S9, ninth sternum; T9, T10, ninth and tenth terga). — Fig. 22 : Aedeagus (ED, ejaculatory duct; PM, parameres). — Fig. 23 : Median sac (MR, middle rod; P, palp-like structure). — Fig. 24 : Distal end of aedeagus, lateral view (E, epimere; H, hypomere). — Fig. 25 : Male reproductive system (AED, aedeagus; AG, accessory gland; EJD, ejaculatory duct; T, testis; VD,

vas deferens; *VS*, vesicula seminalis). — Fig. 26 : Femalee reproductive system (*AN*, anus; *COVD*, common oviduct; *CR*, chitinized rod; *MB*, muscle band; *OV*, ovary; *OVD*, oviduct; *R*, rectum; *SP*, spermatheca; *SPD*, spermathecal duct; *SPG*, spermathecal gland; *T10*, tenth abdominal tergum; *VG*, vagina).

rotized plate, the sternum, which forms the floor of the genital chamber. It is interesting to note that the ninth tergum is much more developed in males than in females (figs. 17, 18, 19 and 20).

In both sexes the tenth segment is represented by a small narrow sclerite which I consider is the tergum of this segment.

The abdominal terga and sterna are almost black or very dark brown, while the intersegmental membranes and the pleura are transparent or creamy in colour

The external Genitalia

The Coleopterous male genitalia and associated parts have been worked by Sharp and Muir (1912), and a general study of the subject has been carried out by Snodgrass (1935). In his comparative study of the external male genitalia of certain Coccinellids, Dobrzhanskij (1926) has illustrated the lobes surrounding the free and distal end of the aedeagus of *Coccinella undecimpunctata* L. In the opinion of the author this study represents only a part of the external male genitalia and a more detailed account is thus given here.

The aedeagus (figs. 21 and 22) is a long curved structure which extends from the second to the eighth abdominal sterna. It is U-shaped in cross section and encloses the distal end of the ejaculatory duct. Normally the aedeagus is partly retracted within a membranous pouch from which it is exerted during copulation. Its walls are strongly sclerotized and its base is produced into a strong apodemal plate which gives an attachment base for the muscles of median sac and the middle sclerotized rod. The latter structures are attached to the distal end of the aedeageal pouch. The median sac is a comparatively large structure which partly encloses and protects the free distal end of the aedeagus. This sac is provided with two pale like hairy structures which arise from its ventral and dorsal surfaces (fig. 23). The sac and the rod seem to function in the exertion of the aedeagus from its pouch during copulation. Since the contraction of their muscles will pull them as well as the pouch anteriorly, a greater part of the distal end of the aedeagus is freely exposed. The distal end of the aedeagus (fig. 24) is further provided with two membranous flaps, the parameres; a dorsal flap, the epimere and a ventral flap, the hypomere.

With the exception of the sclerotized ninth sternum which forms its floor, the walls of the genital chamber are membranous and surround the aedeagus and other associated structures almost completely.

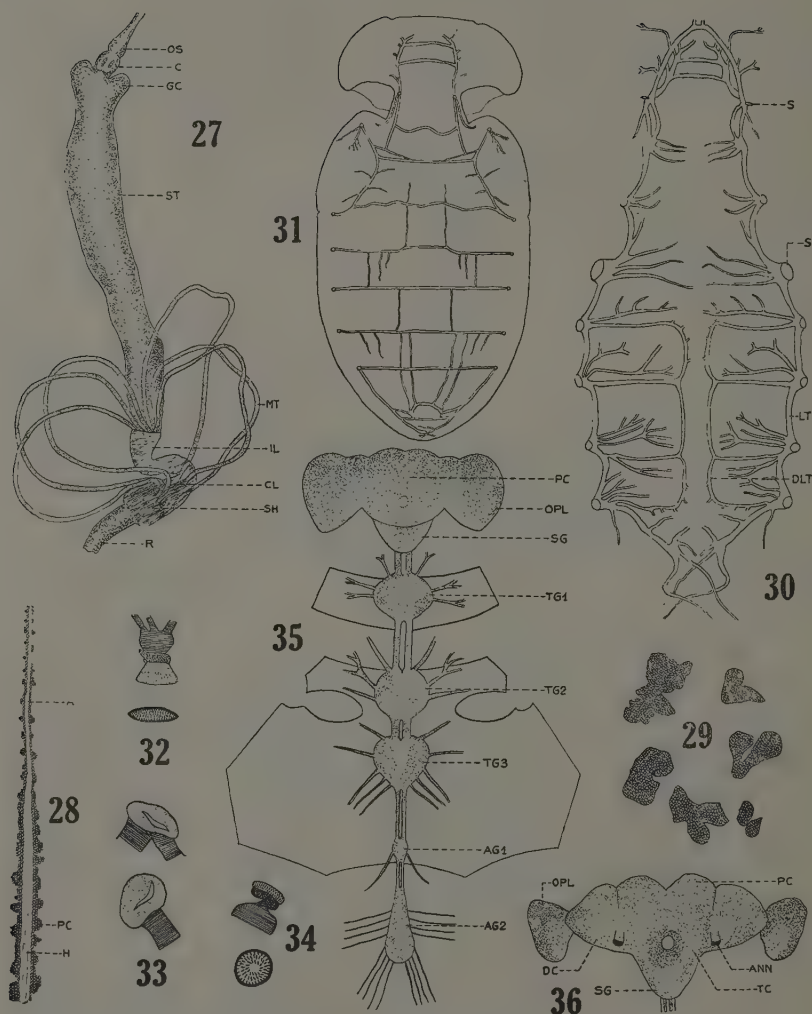


Fig. 27 : Alimentary canal (C, crop; CL, colon; GC, gastric coecum; IL, ileum; MT, malpighian tube; OS, oesophagus; R, rectum; SH, sheath; ST, stomach). — Fig. 28 : Dorsal vessel (A, aorta; H, heart; PC, pericardial cells). — Fig. 29 : Fat body cells. — Fig. 30 : Respiratory system, dorsal view (DLT, dorsal longitudinal tracheal trunk; LT, main longitudinal tracheal trunk; S, spiracle). — Fig. 31 : Respiratory system, ventral view. — Fig. 32 : First thoracic spiracle. — Fig. 33 : Second thoracic spiracle. — Fig. 34 : Abdominal spiracle. — Fig. 35 : Central nervous system, dorsal view (AG1 and AG2, first and second abdominal ganglia; OPL, optic lobe; PC, protocerebrum; SG, suboesophageal ganglion; TG1, TG2, TG3,

first, second and third thoracic ganglia). — Fig. 36: Brain, ventral view (*ANN*, route of antennal nerve; *DC*, deutocerebrum; *OPL*, optic lobe; *PC*, protocerebrum; *SG*, suboesophageal ganglion).

The female genitalia (figs. 17 and 26) are represented by two flattened chitinised rods which are located at the dorsal end of the vagina on both sides of the gonopore. These rods seem to play a part during the process of copulation and oviposition as will be shown later.

The Digestive System

The alimentary canal (fig. 27) is in the shape of a long tube which is slightly longer than the length of the body. The mouth opening leads to a very short oesophagus which dilates posteriorly to form the crop. This organ lies in the first thoracic segment. The gizzard is well developed and is externally marked by two brown patches. The stomach is a long wide tube which extends from the second thoracic to the fifth abdominal segment. Its surface area is increased by the development of two small gastric coeca at its oesophageal end. The malpighian tubes are six in number and are in the form of long convoluted tubes which open separately in the anterior part of the hind intestine. Their distal ends, however, penetrate a relatively thick sheath which encloses the middle region of the hind intestine, the colon. The structure of this sheath and its relation to the distal ends of the malpighian tubes require further investigations.

The hind intestine is divided into three distinct regions: an anterior narrow region, the ileum, a dilated middle region, the colon, and a tubular posterior region, the rectum. The anus opens within the invagination cavity of the eighth abdominal segment between the ninth and tenth terga.

The Circulatory System

The circulatory system is formed chiefly from the dorsal vessel (fig. 28). This organ extends middorsally beneath the body terga from the caudal extremity through the thorax and terminates in the head. The heart forms the wider region of this vessel and is limited to the abdomen. It is in the form of an apparently undivided tube. The aorta is much narrower and extends from the metathorax to the head. The heart is surrounded by masses of comparatively large cells with large rounded nuclei, the nephrocytes, which are supposed to play an important part in excretion.

The Fat Body

The fat body (fig. 29) is formed from large irregular cells which occur chiefly in the abdominal cavity surrounding the interior viscera and to a certain extent in the cavities of the thorax.

The Respiratory System

The respiratory system (figs. 30 and 31) consists of two main longitudinal trunks which run along the dorso-lateral sides of the body from the head to the distal end of the abdomen. These trunks give off seven pairs of spiracles, the first pair being between the prothorax and the mesothorax; the second pair on the mesothorax and the other five pairs are arranged on the pleura of the first five abdominal segments.

The first thoracic spiracle seems to belong to the mesothorax and is ventral in position, its opening takes the form of a narrow oval slit and its atrium is provided with eight rows of short hairs, the trabeculae. In connection with this spiracle there is a closing apparatus to regulate the passage of air in and out of the trachea (fig. 32).

The second thoracic spiracle seems to belong to the metathorax. Its presence in the mesothorax, however, is probably due to migration from the segment behind. This spiracle lies in a flexible membranous fold between the tergum of the mesothorax and its sternum episternum. Its opening takes the form of a narrow slit and its atrium is devoid of any hairs, cuticular outgrowths or closing apparatus (fig. 33).

All the abdominal spiracles are dorso-lateral in position and their openings to the exterior are rounded in shape. The atrium of each of these spiracles is provided with three rows of hairs as well as a closing apparatus (fig. 34).

The two main longitudinal trunks are connected with eleven transverse ventral commissures, two in the head region, two in the mesothorax and one in the metathorax and in each of the first five abdominal segments. Each of the last four abdominal spiracles gives off a short transverse commissure; the commissures on one side are connected together by a dorsal longitudinal tracheal trunk.

The Nervous System

The central nervous system consists of the brain, the suboesophageal ganglion and the ventral nerve cord (fig. 35).

The brain (fig. 36) is formed from the fusion of three pairs of ganglia and chiefly from the protocerebrum which forms its dorsal region. The protocerebrum is developed on each side into a large optic lobe. The deutocerebrum is in the form of a very small lobe on the ventral side of the protocerebrum. It bears the root of the antennal nerve. The tritocerebrum is located on the ventral surface of the posterior region of the protocerebrum and is broadly attached to the comparatively small suboesophageal ganglion without the intervention of connectives.

The ventral nerve cord consists of three ganglionic masses in the thorax and two in the abdomen. These masses are joined together by a pair of

connectives which originate from the posterior part of the suboesophageal ganglion. The connectives are separate and distinct throughout their length. The prothoracic ganglion lies on the floor of the prothorax; it is quadrate in shape and is connected anteriorly with the suboesophageal ganglion by a pair of connectives; it gives off three pairs of nerves. The mesothoracic ganglion lies in the mesothorax and also gives off three pairs of nerves. The metathoracic ganglion lies at the anterior region of the metathorax; it is pear-shaped and gives off five pairs of nerves. The first ganglion of the abdomen is much smaller than any other ganglion: it gives only a single pair of nerves. This ganglion lies at the posterior margin of the metathorax; its presence in this position is probably due to migration from the segment behind. The second abdominal ganglionic centre is very well developed. It is pyriform and lies on the floor of the fourth and fifth abdominal segments. This ganglion seems to represent the fusion of several abdominal ganglia since it gives off eight pairs of nerves.

The Reproductive System

The female reproductive organs (fig. 26) consist of a pair of ovaries which lie in the body cavity of both sides of the alimentary canal starting with the second abdominal segment. The number of ovarioles per ovary varies from 25 to 40 or more each. Their filaments are attached separately to the abdominal tracheae and thus maintain the ovaries in position. The developing oocytes are disposed in the ovarioles one after the other; the oldest being situated nearest the union with the oviduct; while the nurse cells are retained in the germaria. The oviducts take the form of two wide canals which lead from the ovaries. The two ducts unite a short distance from the ovaries to form a common oviduct which opens directly into a median wider passage, the vagina. The latter organ is a cylindrical sac which opens in the invagination cavity of the eighth abdominal segment. Its opening is guarded by two flattened chitinised rods which seem to play a role in guiding the eggs during oviposition and leading the aedeagus during the copulatory process. Opening at the dorsal part of the proximal region of the vagina is the spermathecal duct, whose distal slightly sclerotized end is tucked in this part of the vagina. The spermatheca is three armed and its walls are also sclerotized. While the proximal arm of the spermatheca is free, the distal arm is connected with the spermathecal duct and the median arm is connected with the spermathecal gland. The proximal and median arms, however, are connected together with a muscular band. While the spermathecal gland contains a sac in which the glandular secretions are stored before they are liberated.

The male reproductive organs (fig. 25) consist of a pair of rosette-shaped testis which lie in the body cavity on both sides of the alimentary canal in the second and third abdominal segments. They are maintained in position by the surrounding fat body and tracheae. Each testis gives off a long coiled tube, the vas deferens. Along its course the vas deferens is enlarged to form the vesicula seminalis. The vasa deferentia then unite to form the long coiled tubular ejaculatory duct. Before it enters the aedeagus, the ejaculatory duct is transformed into a well developed and highly muscular tube which thins up in the aedeagus and terminates at its end. Opening at the dorsal wall of the proximal region of the ejaculatory duct are two pairs of long coiled tubules, the accessory glands which open separately into the ejaculatory duct. The distal ends of each pair of tubules, however, are united to form a single continuous tube.

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Contributions towards a knowledge of the Thysanoptera of Egypt, XIV.

(with 14 Text-Figures)

by Dr. H. PRIESNER

38. A REVIEW OF THE SPECIES OF THE GENUS *AEOLOTHRIPS* HAL., PERTAINING TO THE MEDITERRANEAN FAUNA.

The Egyptian species of the genus *Aeolothrips* have proved to be a rather puzzling group of forms which for years I had been unable to identify. I had to go more deeply into this problem and study all European and North African forms available, and also those of Western Asia.

Bagnall has paved the way towards a better knowledge of *Aeolothrips* by his more recent papers « Contributions towards a knowledge of the European Thysanoptera, V » (*Ann. Mag. Nat. Hist.* (10), XIV, 1934) and « A contribution towards a knowledge of the genus *Aeolothrips* with descriptions of new species » (*Ent. Mo. Mag.*, LXX, 1934, pp. 120-127). In the former paper he describes two new Mediterranean forms and gives a table of the species of the « *collaris*-group ». The latter paper contains a discussion on the more valuable characters for the separation of difficult species and the description of some common species which so far escaped recognition as such.

A visit to London in September 1938, gave me the opportunity to see some of the types of the species dealt with in the above cited papers, through the exceptional kindness of my friend Dr. R. S. Bagnall and through the most generous assistance by Dr. F. Laing of the British Museum of Natural History.

To Bagnall's second paper (*Ent. Mo. Mag.*, LXX), I have to make a few remarks, viz. to the species *Aeolothrips propinquus* Bagn. and *Ae. collaris* Pr. In discussing the characters of *Aeolothrips propinquus*, Bagnall correctly puts *Ae. astutus* Pr. (1926), as a synonym to the above (1924). He errs however in stating (1934) : « Priesner did not appreciate another

most important feature in the sensory areas of the antennal joints 3 and 4 which are considerably elongated in this species and run well into the basal third of the fourth joint... », as I had described this character already in 1928 (Thys. Eur., p. 707), as follows: « Ein wichtiger Unterschied, der in beiden Geschlechtern zur Erscheinung kommt, ist der, dass die Sinnesfelder am 3. und noch deutlicher am 4. Glied bei *astutus* viel mehr als die Endhälfte des Fühlergliedes einnehmen, während sie bei *fasciatus* nicht ganz bis kaum mehr als die Endhälfte brauchen ».

On page 125 (t.c.), Bagnall described *Aeolothrips collaris* Pr. but did not know that the specimens which I sent to him years ago were not the true *collaris*, as only the specimens from Biza (Albania) had to be taken as typical (originally marked as cotypes), and some of the specimens sent later by me might have been either pale forms of *intermedius* (common in Albania) or even pale *meridionalis* which form I did not discern at that time. I have examined the male that Bagnall saw and briefly described (Ent. Mo. Mag., 1934, p. 125); this male belongs to *intermedius*, while the true *collaris* male possesses the pair of stout incurved spines (sickle-bristles). I have, however, not seen the female specimen mentioned by Bagnall (t.c., p. 125). In any case, I do not consider *fulvicollis* Bagn., *collaris* Pr. and *brevicinctus* Bagn. as specifically different from one another. Bagnall's species *citricinctus*, *citricollis* and *bucheti* require further study.

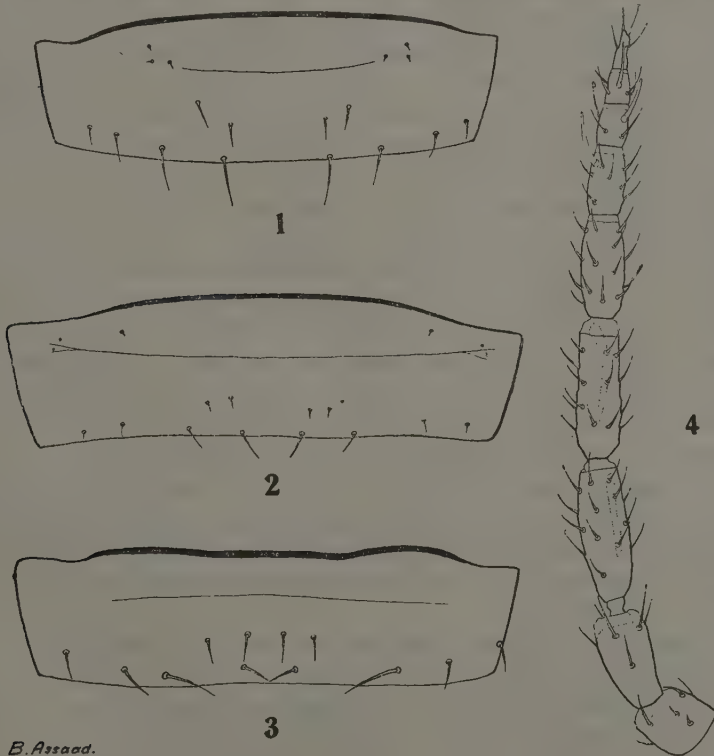
As the intermediate antennal joints are rather variable in their measurements (cf. *intermedius*, *versicolor*), I had been looking for other means of separating the species. I only found one valuable additional character — for the separation of the species around *fasciatus* — that was not known before, i.e. the series of bristles that border the hind margin of the VIIth sternite of the abdomen. There are four pairs of bristles at the hind margin of sternite VII; whilst a group of species has the innermost pair (b.1) rather far apart from each other than to b.2, another series of forms has b.1 closer to each other than to b.2. In the first group of species, b.1 are usually largest, b.4 smallest, while the latter group has b.1 distinctly smaller than b.2. There are species forming the connecting link between the two groups (as e.g. *deserticola*, *propinquus* (fig. 2); *Ae. fasciatus*, *intermedius*, *collaris*, *pyrenaicus*, *linarius* are typical for the first named section (fig. 1); *tenuicornis*, *clavicornis*, *ericae* (fig. 3), for the latter (2).

Some species vary greatly, and it appears to me that with the length of the antennae increasing, that of the wings increases as well, and with

(1) The two pairs of mediodorsal bristles too, show some difference in their position. In the first named groups they are far apart from each other, while they are of about equal distance in *clavicornis* and *tenuicornis* (*anthyllidis*).

the latter the length of the cross-bars. A form of *intermedius* with long cross-bars, I cannot therefore consider as a proper species but merely as a variety of this very common insect, making it sometimes difficult to distinguish from *Ae. fasciatus*, in the female sex.

Particular attention was paid in this paper to the morphology of the males, especially the secondary sexual characters, as for instance the dark dorsal chitinous thickening of the tergum of segment IX and its chaetotaxy, the presence or absence of claspers, or sickle-shaped bristles, or both, and the shape and size of the small appendices of some anterior tergites, as tergites IV to VII. Obviously owing to lack of proper material, Bagnall has not gone more deeply into details of the abdominal morphology of the males. Unfortunately, I am not yet able either to give descriptions and il-



B. Assaad.

Fig. 1 : *Aelothrips intermedius* Bagn., chaetotaxy of sternite VII of abdomen. — Fig. 2 : *Aelothrips deserticola* Pr., chaetotaxy of sternite VII of abdomen. — Fig. 3 : *Aelothrips tenuicornis* f. *anthyllidis* Bagn., chaetotaxy of sternite VII of abdomen. — Fig. 4 : *Aelothrips anebiae* spec. nov., antenna of female. [Figs. 1-3, $\times 200$; Fig. 4, $\times 275$].

illustrations of the male characters of *all* known species, yet I tried a start in bringing them up to 22 different forms. As a whole, males are more easily and sharply distinguished than females, excepting those of *anthyllidis* and *clavicornis*, or *collaris* and *meridionalis*. The latter, I have decided to take as subspecies of one main species, the former will require further study on the base of longer series of faultless preparations which are not at hand at present.

With regard to the terminology of the chitinous appendages of the male abdomen, the following may be noted: On the dorsum of the abdomen, the elongated segment I has the usual longitudinal keels which are almost equal in all species. Tergite II often has a median scale-like thickening which may be easily overlooked. Of special importance are the dorsal chitinous appendices on tergites III, IV, V and VI; the pair on IV may be square or transverse, that on V is usually lanceolate, and there is sometimes another fine linear thickening near fore margin; the appendix on tergite VI may be triangular but generally it is very short, transverse. On tergite IX, there is a dark central plate, usually not reaching base; it is of spherically triangular or semicircular form; it bears a pair of bristles (b.1) near middle, and another at the hind corners (b.2); in some cases however, the interior pair (b.1) lies very close to b.2, in other forms (*linarius* n.sp.) it has an intermediate position. Claspers may be present, forked or simple, or entirely absent. Between the claspers and the lateral hind margin there is an « interstitial » bristle which is longest in *fasciatus* and *propinquus*, surpassing in these species the length of the claspers. A lateral bristle of segment IX may be very stout, almost sickle-shaped (« sickle-bristle », cf. *collaris*, *clavicornis*, *ericæ*) but is weak in others (cf. *fasciatus*, *intermedius*, *linarius*). In fig. 10 the position of these organs is indicated.

In some species, the middle coxae have a tooth-like appendage. This was hitherto only mentioned by Doeksen (*Bijdr. Morphol. Thys.*, Wageningen, 1941, p. 34, Pl. XIV, fig. 93), his figure referring to *intermedius* (not *fasciatus*): in *intermedius*, this coxal tooth is more conspicuous and more pointed than in *fasciatus*, where it is blunter; it is vestigial (e.g., *collaris*) or wanting in most species.

Students of *Aeolothrips* are advised not to consider the key given below, and the grouping of the species therein, as an expression of my opinion on the phylogenetic relationship of the species; it is merely composed as an aid to identification.

The genus may be better divided into sections according to the development of the secondary male characters. Two main sections stand out: One of them containing those species the males of which have no claspers, and the other section those *with* claspers on segment IX. The former section

must be called *Aeolothrips* s.str. (as *Ae. albicinctus* Hal., belonging to this section, is the type of the genus), the latter is subgenus *Coleothrips* Hal., with *fasciatus* L. as type.

I tried in vain to discover specific differences between *Ae. anthyllidis* Bagn. and *Ae. tenuicornis* Bagn. I have seen the type specimen of *tenuicornis* and I am in possession of a paratype. They have somewhat longer antennal joints than *anthyllidis* but neither in the coloration nor in any morphological detail I was able to find a difference, and some of the specimens of Morison's collection may be assigned to either of the two species in question. The shape of the sensory areas (on joint 4) terminating more or less close to the apical margin varies greatly; the colour of the antennae and wings and the bars on them, as well as the chaetotaxy of the abdomen (sternite VII) are equal in both forms. Further material, however, will be necessary to definitely prove that my assumption of the identity of the two species is correct. As there is some slight difference in the length of the antennae, I should wish to keep *tenuicornis* and *anthyllidis* as varieties of one species.

In 1933 (*Redia*, XX, pp. 156-187), Melis described several new species of *Aeolothrips*. Of these, *Ae. perclarus* (t.c., p. 156, figs. V, VI, VII) is certainly identical with *collaris*, at least the specimens labelled « Carduaceae (San Vincenzo, July) » which I could examine through the courtesy of the author. I have to remark, however, that the illustration (fig. VI, 4) is not in conformity with the characters of *collaris*; but this may be due to the fact that these drawings are somewhat schematic and need not be taken as being accurate in every minute detail. The statement that the 2nd antennal joint is entirely yellow is not correct as in the specimens from San Vincenzo joint 2 is very distinctly shaded. *Aeolothrips speciosus* Melis is identical with *ericae* Bagn. (*nobilis* Pr.). *Ae. angustus* Melis may be identical with *intermedius* Bagn., as the male has no incurved pair of bristles on segment IX of the abdomen, though I have not seen the original specimens. *Ae. obesus* Mel. and *Ae. negletus* Mel. are not sufficiently described as to be compared with the known species. They are, however, most probably referable to species already known.

Apart from the species dealt with in this paper, I am in possession of a number of slides containing specimens which cannot be identified with certainty, nor published until both sexes of them will be at hand.

The accomplishment of this paper is largely due to the assistance of some of my colleagues who have supplied me with material or have permitted me to study type specimens of their collections. My thanks are due to Dr. R. S. Bagnall, G. A. Mavromoustakis, Dr. A. Melis, and Dr. G. D. Morison. For specimens of *Aeolothrips fasciatus* from America

I am obliged to my old friend Prof. J. D. Hood. For the drawings I am indebted to Boutros Assaad Eff., artist to the Ministry of Agriculture.

**NOTES AND RECORDS ON CERTAIN SPECIES
AND DESCRIPTIONS OF NEW FORMS**

1. *Aeolothrips arnebiae* spec. nov.

(Figs. 4 and 8)

Female: Chestnut-brown; mesodermal pigment in thorax orange, in the abdomen orange to pale crimson; antennal joints 1, 2 and 4 to 9 grey-

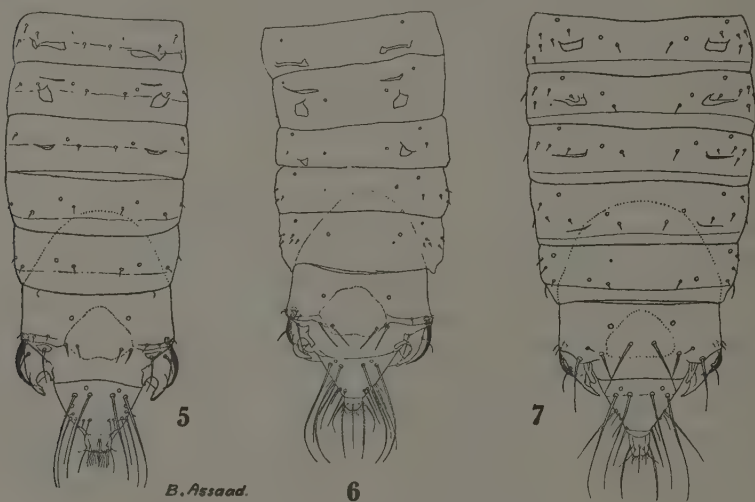


Fig. 5: *Aeolothrips collaris* Pr., abdomen (from segment IV) of male. — Fig. 6: *Aeolothrips collaris* ssp. *meridionalis* nov., abdomen (from segment IV) of male. — Fig. 7: *Aeolothrips clavicornis* Bagn., abdomen (from segment IV) of male. [× 120].

brown, 2 at apex and the whole of 3 pale yellowish grey, the latter somewhat darker at apex. Legs dark, grey brown. Wings with two separate dark cross-bars, the first short, the second somewhat longer. Bristles of body dark. Antennae very characteristic, much as in *Desmothrips* Hood, joint 3 comparatively short, 6 comp. very long, 1.7-1.8 times as long as broad, all following joints longer than broad. Sensory area on joint 3 reaching basal third, on 4 broad, curved, running into basal third or fourth. Cephalic bristles very fine. Pronotal bristles pale, fine, 5-7 pairs along hind margin. Lateral bristles of mesoscutum thin. Bristles on the abdominal sternites

thin, b.1 on hind margin of sternite VII somewhat farther apart (but not twice as much) from each other than from b.2. Wings somewhat widened towards apex, broadest across bar 2.

Measurements of holotype, in μ : Head length from eyes 152; pronotum length 188; wings length 882; antennae length 398; antennal joints, lengths (widths): 31-34(36), 53(28), 80(25), 71-73(24), 53(22), 34-35(21), 20-21(17), 18-20(13), 20(8). Bristle 2 on segment IX, 180, b.1 on segment X, 200. Hind tibiae length 295. — Total body length (distended) 2.1 mm.

Male: Little paler than female, fore femora and fore tibiae paler along middle longitudinally, colour of antennae as in female. Wing bars paler. Antennae as in the female. Tergite V with transverse appendix which is rounded apically, VI with very short and indistinct appendix. Posterior margin of tergite IX slightly rounded, median dorsal bristles as fine as laterals (fig. 8), separated from each other but not as far as in *collaris*, interstitial bristle short, shorter than the claspers the inner branch of which is but a short triangular tooth. Sickie-bristle developed but rather weak.

Measurements of allotype: Antennae length 363; joints lengths (widths): 28(33), 48(26), 70(24), 67-76(20), 48(20), 31-34(18), 22(15), 14-17(12), 17(8). Wings length 795. Hind tibiae length 260. Interstitial bristle 32-36; b.1 on plate of tergite IX 16; b.1, 2 on tergite X 140. Length of tergite X 72. Total body length (distended): 1.56 mm.

Habitat: 1 female and 2 males, North Sudan, Wadi Shellal, near Red Sea coast, March 3, 1938, in flowers of *Arnebia hispidissima* DC., leg. H. Priesner.

This species differs from all species hitherto described by the unusually long terminal antennal joints. The secondary male characters show it to be a true *Aeolothrips* (s.str.) ⁽²⁾.

2. *Aeolothrips clavicornis* Bagnall

(Fig. 7)

Common in England and Scotland (coll. G.D. Morison), in France and also in Holland (coll. J. Doeksen).

3a. *Aeolothrips collaris* Pries.

Originally recorded from Albania (Biza). This species is characterized by its vivid coloration, yellow prothorax and greater part of femora. The

(2) Antennae practically as in *Desmothrips* Hood, but sensory areas straight as in all *Aeolothrips* species; in *Desmothrips*, the sensory areas are, though fine and longitudinally situated for their greater part, circumpolarly extended at least on joint 4, and elongate on joints 5 and 6.

cross-bars of the wings are short in most cases. The antennae vary in length. Specimens with long antennae (and longer sensory areas) in which joints 3, 4 and 5 measure about 108, 108 and 82 μ may be considered as f. *fulvicollis* Bagn.

New records: Sardinia (Sedda del Pranu, Monti del Gennargentu, from grasses; leg. A.H. Krausse). Yugoslavia (Cotor, VIII, on *Lythrum salicaria*; leg. H.H. Karny). Albania (Tirana; leg. Kemal Butka). Cyprus (Cherkes, X, Episkopi, VI, on *Anthemis*; leg. G.A. Mavromoustakis). Palestine (Gedera, III, on *Eryngium creticum*; Rehovoth, V, on *Cephalaria joppensis*; Zichron Yakouv, V, on *Chrysanthemum*; leg. E. Rivnay). Egypt (Cairo-Gezirah, VI, on *Medicago sativa*; Orman Garden, V, in flowers of *Poinciana regia*; Gizah, V, in flowers of *Vitex agnus-castus*; Faroukija, V, on grasses; Saft-el-Milouk, IV, on thistles; Helouan, Wadi Geraui; leg. H. Priesner).

3b. *Aeolothrips collaris* ssp. *meridionalis* nov.

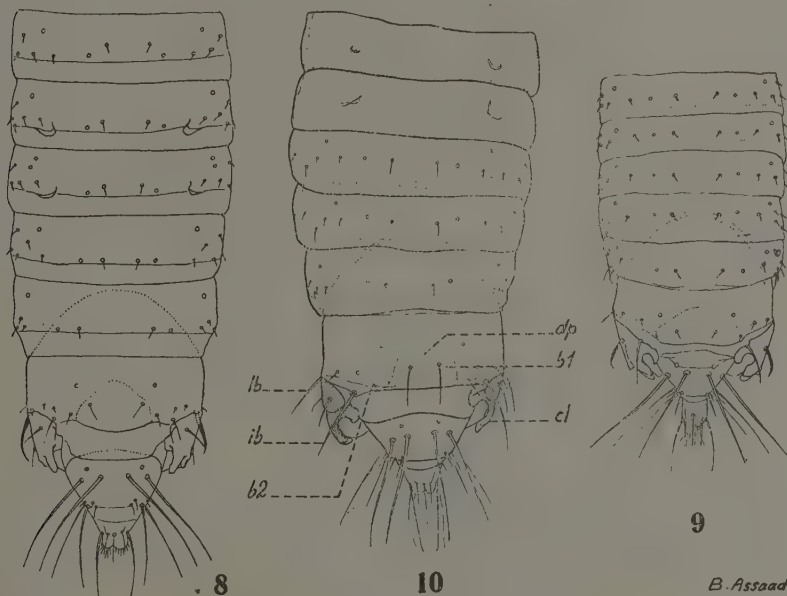
In its structural characters practically identical with the typical *collaris*, but in the coloration of the body similar to *intermedius* Bagn.; colour of legs as in this species but antennae with joint 3 white, shaded but at extreme apex (as in *fasciatus*), joint 2 pale in apical half or less, fore tibiae as in *intermedius*, i.e. somewhat paler along middle. Wing bars long, longer than broad, about as in *intermedius*.

In the male, the appendix of tergite VI is usually somewhat better developed than in *collaris*.

Measurements of types, female (holotype): Antennae length 450-467, joints lengths (widths), 36(36), 64(28), 104(25), 100-104(25), 84(25), 22(20), 20(16), 18(12), 12(5); head length 156, prothorax length 168, pterothorax width 330, hind tibiae length 330, bristles 1, 2 of tergite IX 168, b. 3 180 μ ; wings length 1.09 mm. — Male (allotype): Antennae length 380, joints lengths (widths) 34(30), 50(25), 83(20), 81(22), 70(23), 17(18), 13(15), 10(10), 8(6); length of interstitial bristle of segment IX 40, length of bristles on segment X 135; wings length 795 μ .

The only *Aeolothrips* species recorded from Egypt, before I began the survey of the Thysanoptera of this country, was *Aeolothrips fasciatus* (Willcocks, The Insects and related Pests of Egypt, II, 1925, p. 81, fig. 3 a, b). After Bagnall's *Aeolothrips* studies, however, it became evident that the common dark Egyptian species occurring on gramineous crops could not be *fasciatus* L., Bagn. It appeared to be a form most closely allied to *collaris* Pr. (nec Bagnall). The difficulty consisted in separating this *fasciatus* Willcocks from *collaris*. A comparison between dark specimens of the Egyptian form with the types of *collaris*, both strikingly

different in colour, would suggest specific value of both. But the material at hand contains many transitional specimens, from Egypt, Palestine and Cyprus, that could be allotted to either of the two forms. I cannot, therefore, consider them as two different species. The males as well are extremely similar in their main characters. There is variation in the length of the antennae and their sensory areas, and in the lengths of the cross-bars of the wings. The vividly coloured form (3a) with short cross-bars and



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Fig. 8 : *Aeolothrips arnebiae* spec. nov., abdomen (from segment IV) of male. — Fig. 9 : *Aeolothrips linarius* spec. nov., abdomen (from segment IV) of male. — Fig. 10 : *Aeolothrips fasciatus* L., abdomen (from segment IV) of male (b1, bristle 1 of dorsal plate of tergite IX; b2, bristle 2 of dorsal plate of tergite IX; cl, claspers; dp, dorsal plate of tergite IX; ib, interstitial bristle of segment IX; lb, lateral bristle of segment IX). [$\times 120$].

longer antennae agrees with *fulvicollis* Bagn. (of which I am in possession of a specimen from Pusa (India), ex coll. Ramakrishna Ayyar). Moreover, *Aeolothrips brevicinctus* Bagn. does not seem to be specifically different from either *collaris* or *fulvicollis*; the male (specimen in coll. Bagnall) is certainly not different from that of *collaris* m. I have therefore come to the conclusion that *fulvicollis* may be maintained as a variety of *collaris*, whilst *meridionalis* may be considered as a subspecies of *collaris*.

Habitat: The type specimens (both sexes) from Cyprus (Limassol, II-III, from *Papaver rhoeas* and swept from turf; Spalagiotissa Monastery, III; Yermasoyia River, II, on *Sinapis*; leg. G.A. Mavromoustakis). Other records: Palestine (Mikveh Israel, III, on *Melilotus sulcatus*; Ain Harod, II, on *Anthemis*; Tabor Caduri, III, in flowers of *Prunus amygdalus*; leg. E. Rivnay). Syria (Damaskus, IV; leg. W. Wittmer). Egypt (Cairo-Dokki, VI, 1920, in ears of wheat, leg. S. Bahgat; Gizah, II, on *Pisum*; Marg, II; Cairo, III, in flowers of *Raphanus sativus*; Meadi, II, on *Zilla spinosa*; Wadi Geraui, V; Burkane, IV, on grasses; Damiette, III, on *Triticum sativum*; Fayoum, III, in flowers of *Silybum marianum*; Faroukija, V, on grass; Oasis Kharga, III, on *Triticum*; leg. H. Priesner).

Transitional forms to *collaris* (typ.): Albania (Elbasan, IX, swept from grasses; H. Priesner). Egypt (El Wasta, III; Damiette, III, on *Triticum*; Wadi El-Tih, V, on *Haloxylon schweinfurthi*; Fayoum, III, in flowers of *Silybum marianum*; leg. H. Priesner).

4. *Aeolothrips deserticola* Pries.

(1937, *Bull. Soc. Roy. Ent. d'Egypte*, p. 214, fig. 2; p. 216, fig. 4).

New record: Palestine (Delhamia, III, on *Erucaria* and *Diplotaxis erucoides*; leg. E. Rivnay).

5. *Aeolothrips ericae* Bagn.

New records: Sardinia (Sorgono, IV, 1912, leg. Krausse), ex coll. Karny. Cyprus (Pyrgos near Limassol, II, leg. G.A. Mavromoustakis).

6. *Aeolothrips fasciatus* L., Bagn.

(Fig. 10)

This species was never described as it was confused by Uzel and myself with *intermedius* Bgn.. Bagnall described the latter species in 1934 (*Ent. Mo. Mag.*, 70, p. 123).

Ae. fasciatus is a large, black species with a rich amount of crimson mesodermic pigment, *wholly dark legs*, white third antennal joint which is shaded usually but at *extreme* apex. Antennae slender, with particularly slender joint 3-5. Wings very *narrow*, with long cross-bars.

It is difficult to distinguish from *intermedius* in the female sex, but is easily separated from it by the characters of the male. The latter has the antennae much longer and slenderer than in *intermedius*, the appendices

on abdominal tergites IV and V vestigial, the interstitial bristle of tergite IX very long (fig. 10).

Ae. fasciatus is in Central Europe much less common than *intermedius*. It is common in North Europe and may be more prevalent in the Alps. It occurs in North America.

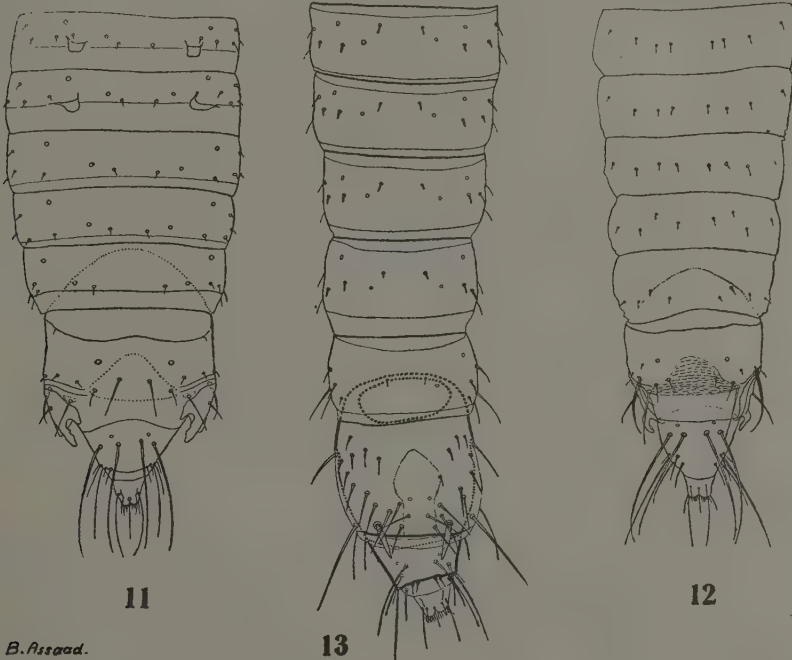


Fig. 11 : *Aeolothrips intermedius* Bagn., abdomen (from segment IV) of male. — Fig. 12: *Aeolothrips mas-flavus* Pr., abdomen (from segment IV) of male. — Fig. 13 : *Aeolothrips wittmeri* Pr., abdomen (from segment IV) of male. [$\times 120$].

7. *Aeolothrips ghabni* Pries.

(1937, *Bull. Soc. Roy. Ent. d'Egypte*, p. 214, fig. 1, p. 216, fig. 3).

New records : Palestine (Rehovoth, III, on *Ipomoea palmata*, *Calendula* sp., *Tulipa caronensis*, *Anchusa aggregata*; Gan Hajim, II, on *Alkanna tinctoria*, ibidem, IV, on *Silene odorata*, *Papaver rhoeas*, *Anchusa aggregata*; Ayanoth, X, *Antirrhinum*; Kafr Gileadi, III, on Cruciferae; Tabor Caduri, III, on *Prunus amygdalus*; Jordan Valley, IV; leg. E. Rivnay).

8. *Aeolothrips intermedius* Bagn.

(Fig. 11)

Neither this species nor *fasciatus* I have ever seen from either Cyprus, Palestine or Egypt. It is distributed well over Europe, the most common species in Central and Eastern Europe (Rumania!) The most southern record at hand: Albania (Tirana).

9. *Aeolothrips linarius* spec. nov.

(Fig. 9)

Female: Blackish brown, legs as well, fore tibiae sometimes paler towards apex. Antennal joints 1, 2 and 4-9 dark, 2 paler apically, 3 white to greyish white, shaded about apical third, about as in *intermedius*. Cross-bars of wings long, both somewhat longer than broad, the white central bar distinctly shorter than the dark bars, the 2nd of the latter beginning with the second cross-vein. Antennae shorter than in *intermedius*, sense-area on joint 3 short, 26-32 μ , on 4 also hardly reaching middle of joint (32-36 μ), or this only in exceptional cases, arched, broad, not quite reaching tip of joint; joint 4 distinctly longer than 5. Hind margin of pronotum with 7-9 small setae. Transversal striation of pronotum indistinct, visible faintly but towards basal margin. Bristles at hind margin of sternite VII long, b.1 widely separated from each other, nearly or wholly twice as far apart as from b.2.

Measurements of female (holotype), in μ : Head length (from eyes) 160, width 190; antennae length 398; joints lengths (widths), 34-36(34), 56(28), 95-98(22), 74(22), 62(22-23), 18(20), 14(17), 17(13), 14(6); pronotum length (width) 156(242); pterothorax width 345; wings length 950, width across 2nd cross-bar 172, length of cross-bars 208-225; length of hind tibiae 285; bristle 1 on sternite VII 56; length of tergite IX 104, tergite X 92; bristles 1, 2 on tergite IX 176-180, b1, 2 on X 168-172. Total body length (distended): 1.59-1.89 mm.

Male: Body colour and cross-bars as in female. Antennal joint 3 grey or at least the entire apical third shaded. Sensory area on joint 4 broad, arched, short (20-24 μ), on joint 3 short (18-22 μ): joint 5 always somewhat shorter than 4. *Tergum of abdomen without chitinous appendices*, central plate of tergite IX somewhat sinuated at hind margin (as in *collaris* and ssp. *meridionalis*), rounded in front, not reaching base, central bristles of plate (b.1) farther distant from each other than in either *ghabni* or *clavicornis*, but not so close to the sides of plate as in *collaris* or *meridionalis*; these lateral setulae are very fine. Interstitial bristle about as long as claspers. « Sickie-bristle » not thickened, almost as weak as in *intermedius*.

Measurements of male (allotype), in μ : Antennae length 330; joints lengths (widths), 29(29), 48(22), 73(20), 55(19-20), 55-56(21), 17-18(18), 14-15(14), 13-14(10), 11(6); head length (width) 144-148(180); pronotum length 120; pterothorax width 268-277; tergite IX length 72-76; distance of central bristles on plate (of tgt. IX) 44-50, from laterals (b.2) 28-40; length of central bristles 20; length of interstitial bristle 48-52; of laterals on IX 48-52; bristles on X 144-148. Hind tibiae length 242. Total body length (distended) 1.21 mm.

This new species is, though rather similar to *intermedius*, very well characterized. The male is easily separated by the absence of the dorsal appendices of the tergites, as well as by the chaetotaxy of tergite IX. Both sexes have much shorter antennae; joint 4 measures but 64-80 μ in the female, whilst in *intermedius*, *fasciatus* and *meridionalis* it is 88-116 μ long. The sensory areas on joints 3 and 4 are much shorter than in the species just mentioned; joint 3 is almost wholly grey or shaded in apical half (rarely third), always with darkenings not well defined. From all species of this group it is further distinguished by its smaller size.

Habitat: 16 females and 2 males, Palestine, Beit Kerem, 30.III.1936, in flowers of *Linum mucronatum*, leg. E. Rivnay.

10. *Aeolothrips montivagus* spec. nov.

(Fig. 14)

Female: Pale yellow. All legs pale yellow, just the more strongly chitinated part of tarsal tip dark. Body with more or less faint grey shadings, especially pale grey spots on pterothorax, fine dark basal lines on the median sternites, not reaching sides; segment X distinctly shaded except about its basal third. Antennae whitish yellow, joint 3 with fine grey line at apical margin, 4 pale about basal 4th or 3rd, rest of antenna dark. Cross-bars of wings *very short*, basal bar much broader than long, *apical one dissolved into spots*. Bristles on thorax and end of abdomen dark, on head and prothorax pale.

Head normal. Antennae short, joint 5 distinctly shorter than 4. Sensory area on joint 3 well surpassing middle of joint, on 4 broad, arched, reaching basal third. Armature of fore tarsi normal. The pale median bristles (b.1) of sternite VII somewhat farther (but not twice as far) apart than from laterals (b.2).

Measurements of holotype (female), in μ : Antennae length 407; lengths (widths) of joints, 39(34), 67-70(28), 106(25), 78(26), 57(25), 18(19), 14(15), 12(10), 11(6). Pterothorax width 346; wings length 917; bristles 1 of tergite IX 180, b.2 200; bristle 2 of segment X 164-168. Length of hind tibiae 295. Total body length (distended): 1.56 mm.

Male: Wholly pale yellow, with faint shadings on the thorax, and with grey dorsal plate of tergite I. Antennal joints 1-4 whitish, 4 slightly shaded at apex, joints 5-9 light grey. Wings as in the female. Abdominal segment X but apically with grey shadings. Segments VI to VIII with numerous small dorsal setae. Bristles pale. Dorsum of abdomen without chitinous appendices. Segment IX distinctly rounded laterally, slightly rounded apically, with a transverse ridge parallel to hind margin, not darker than the rest of the tergite (fig. 14).

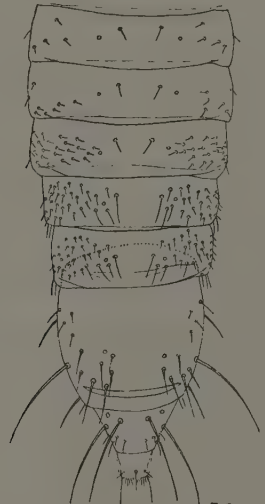


Fig. 14 : *Aeolothrips montivagus* spec. nov., abdomen (from segment IV) of male. [$\times 120$].

Measurements of male (allotype), in μ : Antennae length 380-390; lengths (widths) of joints, 34-36(34), 59-62(26-27), 94-98(22), 84-87(22-23), 62-66(21-22), 17(15-17), 11(13), 9(8-9), 9(5-6). Length of wings 796-813 (several specimens), width across 2nd cross-bar 123-126. Longest lateral bristle of segment IX about 140; length of segment IX 205, width 200-208. Length of hind tibiae 260.

Quite a distinct species. From *gloriosus* Bgn. it is distinguished by the nearly wholly pale antennal joint 3, the pale segments VIII and IX of the abdomen and the much shorter cross-bands of the wings. The male of *gloriosus* is not known yet but it will differ by the complete second cross-bar of the fore wing.

Habitat: 1 female (holotype), numerous males (allotype) and

paratypes), Cyprus (Mount Troodos, 5-6000 ft., VI, 1937, leg. G. A. Mavromoustakis).

11. *Aeolothrips propinquus* Bagn.

A comparatively rare species. New records : Syria (Beirut, IV, leg. W. Wittmer). Palestine (Hamma, IV, leg. E. Rivnay).

12. *Aeolothrips tenuicornis* Bagn. and var. *anthyllidis* Bagn.

(Fig. 3)

Common in England. New record : Spain (Sierra Nevada, 3481 m., on snow field, leg. R. Ebner).

13. *Aeolothrips versicolor* Uz, f. *similis* Pr.

The male of this species is yet undescribed. Years ago, W. Knechtel sent me a specimen for examination of which I had been keeping a brief description, as follows :

Colour of body as in the female, but fore legs wholly pale; joint 1 of maxillary palpi, middle and hind femora pale yellow, tibiae as in female. Joints 1 and 2 of antennae pale, 3 pale in basal two thirds, 4 with light subapical ring. Lengths of antennal joints from 3rd : 68, 64, 44-46, 10, 12, 12, 8-10 μ . Segment IX of abdomen long (160 μ ventrally), *without clasps*, without sickle-bristle. Postero-angular bristles on segment IX 46 and 50 μ . Lateral bristle (b.2) on segment X 112 μ . Colour of wings as in female (f. *similis*) but the dark cross-bars short, and thus the median white bar very long. Length of hind tibiae 208-212 μ .

Habitat : Rumania (« Schlangeninsel », VII, 1931, on *Atriplex* sp.; leg. W. Knechtel).

14. *Aeolothrips wittmeri* Pries.

(1935, *Bull. Soc. Roy. Ent. d'Egypte*, p. 315, figs. 1, 2 [♀]).

(Fig. 13)

Male : Pale yellow with grey markings. Vertex, a median longitudinal line on pronotum, the pterothorax for the greater part, abdominal segment I, fore margins of segments II to VII (broader on VI and VII), a broad central spot on VIII, with usually two lateral dots (or segments VI to VIII almost wholly grey); *segments IX and X blackish brown*. Middle and hind tibiae grey-brown, tips — not sharply defined — pale, hind femora light at base (more or less) and interior margins, fore femora and fore tibiae light, with grey outer margins. Whitish or yellow are antennal joints 1, distal half of 2 and basal half or more of 3. Wings as in the female.

Body slender, sensory areas on joint 3 reaching about middle, on 4 running well into basal third or fourth, arched. *Between and behind ocelli a pair of more prominent, dark bristles.* Dorsal appendices of abdomen wanting. Segment IX elongate, strongly chitinized, more strongly setose than in any of the known species, *without claspers but with a pair* (25 μ) *of stout, dark spines* (fig. 13).

Measurements of allotype, in μ : Antennae length ab. 400; joints lengths (widths), 28-31(35), 56(27), 100-104(24), 90(24), 76(24), 11(17), 11(14), 13-14 (13-14), 11(6). Head length 160; prothorax length 144; pterothorax width 310; length of segment IX 142, width ab. 192. Hind tibiae 285. Wings length 861, width 138. Total body length (much distended) : 1.7 mm.

Habitat : This species was originally described from specimens from South Sinai. It seems to be widely distributed over Egypt, as the following records show : Wadi Rish-Rash, IV, leg. Farag; Baharia Oasis, III, on *Zilla spinosa*, leg. Moh. Hussein; both sexes in numbers, Wadi Am-baga, Kosseir, III, on *Zygophyllum coccineum*, leg. H. Priesner.

KEY OF THE SPECIES OF AEOLOTHRIPS OF EUROPE AND NORTH AFRICA

I. Females

- 1(74) General coloration of the body dark, not pale yellow.
- 2(62) Middle and hind tibiae dark.
- 3(58) Segment X of abdomen dark.
- 4(38,51) Prothorax dark. Abdomen wholly dark, or some of the *anterior* segments paler in immature specimens (f. *adustae*).
- 5(a,b) Fore wings with 2 separated dark cross-bars. (In *deserticola* and *ghabni*, the costal vein between the dark bars is shaded at hind margin of wing) [cf. pages 334 and 335].
- 6 (7) Joint 4 of the antennae pale, darkened at apex or in apical half ...
..... *priesneri* Knechtel
- 7 (6) Joint 4 of antennae dark.
- 8 (9) The four-jointed style very long, joint 6 of antennae much longer than broad (34-35:21 μ), joint 5 not even twice as long as 6.
..... *arnebiae* spec. nov.
- 9 (8) Style much shorter, normal.
- 10(23) The two median bristles (b.1) on hind margin of sternite VII more widely separated from each other than from the laterals (b.2), and as long as or somewhat longer than these (cf. fig. 1); the two pairs of accessory (dorsal) bristles of sternite VII very far apart from each other.

- 11(12) Sensory area of antennal joint 3 reaching (towards base) far beyond middle, narrow as that of joint 4 which reaches into basal third; joint 2 dark at base only. Length of joint 3, 136-140, of 4, 100 μ . Large species. *melisi* Pr.
- 12(11) Sensory area on joints 3 and 4 shorter.
- 13(16) Antennal joint 4 shorter than 5 or almost as long as it. Smaller species, resembling *linarius*.
- 14(15) Length of hind tibiae ab. 295 μ . Antennal joint 3:90 μ . Length of second cross-bar 208-225 μ *pyrenaicus* Bagn.
- 15(14) Length of hind tibiae 225 μ . Antennal joint 3:66-68 μ . Length of second cross-bar 155-173 μ (doubtful species)
- 16(13) Antennal joint 4 at least somewhat longer than 5.
- 17(22) Antennae longer, joint 4: 88-116 μ .
- 18(19) Joint 4 usually five times as long as broad. Wings narrow, cross-bars longer than in the two following species, anterior bar about twice as long as broad at fore margin, at least 240 μ long. Fore tibiae wholly dark. Antennal joint 2 almost wholly dark, 3 very slender, white, shade at extreme tip more sharply defined. Body pigment crimson *fasciatus* L., Bagn.
- 19(18) Cross-bars somewhat shorter. Fore tibiae usually paler along middle. Body pigment orange or paler crimson.
- 20(21) Antennal 5 distinctly shorter than 4, about as long as the four terminal joints united, joint 4 four to four and a half times as long as broad, joint 2 pale at apex, 3 darkened (not sharply defined) in apical third (or somewhat more). Pigment orange to light crimson. *intermedius* Bagn.
- 21(20) Antennal 5 but very little shorter than 4, somewhat longer than 6 to 9 together; joint 2 yellowish white about in distal half, 3 clear yellowish white, at extreme tip (more sharply defined) dark. Body pigment orange, at extreme tip of abdomen crimson. *collaris* ssp. *meridionalis* nov.
- 22(17) Antennae shorter, joint 4: 64-80 μ . Sensory areas relatively very short. *linarius* spec. nov.
- 23(10) The two median bristles (b.1) on hind margin of sternite VII closer to each other (and often somewhat shorter) than to the lateral bristles (b.2); if the distances (2-1-1-2) are equal, then antennal joint 3 is much darkened. The two pairs of accessory bristles on sternite VII little distant from each other, the median pair usually not twice as far apart than these from the laterals.
- 24(25) Antennal joint 2 wholly whitish yellow; sensory areas on antennals 3 and 4 reaching far downward; dark cross-bars on wings very long. *ericae* Bagn. f. *aterrima* Hukk.

- 25(24) Antennal 2 at least basally dark. The dark cross-bars at most as long as in *intermedius*.
- 26(27) Sensory area on joint 4 little arched, evenly wide, reaching about middle but not quite apex of joint. Large species with long, slender antennae (joints 3, 4, 5 : 125-132, 92-110, 82-95 μ). *tenuicornis* Bagn.
- 27(26) Sensory area otherwise, either broader and distinctly arched or very short or very long.
- 28(31) Sensory areas on joint 3 and 4 *short*, usually occupying about apical third, rarely reaching middle.
- 29(30) Antennae slender, longer; joints 3, 4, 5 : 105-115, 87-100, 79-87 μ ; joint 3 shaded but at apex. *tenuicornis* f. *anthyllidis* Bagn.
- 30(29) Antennae stouter, shorter; joint 4 more dilated towards apex; joints 3, 4, 5 : 93-104, 70-76, 62-81 μ , respectively *clavicornis* Bagn.
- 31(28) Sensory areas of joints 3 and 4 *long*, that of 4 reaching beyond middle ⁽³⁾, joint 3 comparatively dark, never whitish yellow for the greater part.
- 32(33) Costa at hind margin of fore wing not shaded between the dark cross-bars, the latter short. Pronotum without minute transversal striation. Fore legs comparavately short, femora stout. Sensory areas longest of all species. *propinquus* Bagn. (*astutus* Pr.)
- 33(32) Costa of fore wing at hind margin between the dark cross-bars mostly shaded. Pronotum with more or less conspicuous structure of minute transversal anastomosing lines. Fore legs longer, as usual.
- 34(37) Antennae longer and slenderer, joint 5 more parallel-sided. Bristles 1 on posterior margin of sternite VII closer to each other than to bristles 2.
- 35(36) Sensory areas, particularly on joint 3, somewhat longer. Hind marginal costa between bars distinctly shaded *ghabni* Pr.
- 36(35) Sensory areas shorter. Costa between bars not or hardly shaded. *ghabni* ssp. *insulanus* Pr.
- 37(34) Somewhat smaller species; antennal joint 5 shorter, more strongly convex laterally. Bristles 1 of sternite VII about as far apart from each other as from bristles 2; all posterior marginal bristles moderately long. Pronotum very conspicuously transversally striated. *deserticola* Pr.
- a(5, b) Fore wings with only one dark cross-bar which extends along posterior margin as longitudinal band. Antennals 3 and 4 pale or but slightly shaded *vittatus* Hal.

(³) In doubtful cases bristles 1 of sternite VII not twice as far apart from bristles 2 as from each other.

- b(5, a) Fore wings with two dark cross-bars which are broadly united at hind margin. Joint 4 of antennae pale at base only *melaleucus* Hal.
- 38(4,51) Prothorax pale yellow to orange-brown, sometimes with dark central spot. Abdomen dark, in immature specimens some of the anterior segments paler.
- 39(48) Sensory area of antennals 3 and 4 long, running down at least to middle of joint.
- 40(43) Antennal joint 3 wholly dark or paler at base only, sometimes whitish at basal third.
- 41(42) Large, vividly coloured species in which prothorax and base of abdomen (with dark median line), fore legs for the greater part, and base of middle and hind femora are pale yellow. Antennal 3 whitish in basal third. Cross-bars of fore wings narrowly united at hind margin by a dark costal line cf. *wittmeri* Pr.
- 42(41) Smaller, 'dull coloured species. Prothorax dark brown, somewhat paler at margins. Abdomen wholly dark. Fore femora stout cf. *propinquus* Bagn.
- 43(40) Antennal joint 3 whitish yellow, darkened apically, joint 2 wholly white or pale yellow.
- 44(47) Femora dark, fore femora sometimes pale within. Cross-bars short.
- 45(46) Body heavier. Joint 3 five times, 4 four times as long as broad. 6 considerably longer than 7 and not quite as broad as long; sensory area on 4 reaching into basal third; 3 shaded at apex, to a greater extent than in either *bucheti* or *citricollis* *citricinctus* Bagn.
- 46(45) Body less heavy. Joint 3 five and three-quarters, 4 about five times as long as broad; sensory area of 4 running somewhat beyond middle, of 3 reaching about middle; joint 6 not much longer than 7 and considerably broader than long *citricollis* Bagn.
- 47(44) Femora pale, much paler than tibiae cf. *collaris* Pr.
- 48(39) Sensory area on joint 4 not or hardly attaining, very seldom surpassing middle, that on 3 never reaching middle.
- 49(50) Antennal joint 2 clear yellow, 3 shaded at extreme tip. Legs dark, fore tibiae somewhat lighter longitudinally. Cross-bars short. Antennae slender, joints 3 to 5 : 135(28), 128(27), 100(29) μ ; sensory area on 3 and 4 occupying up to the distal third (0.35-0.32) or thereabouts. *bucheti* Bagn.
- 50(49) Antennal joint 2 distinctly shaded at least at base *collaris* Pr.
- 51(38,4) Apex of abdomen dark, but some of the anterior segments (usually II or also III) clear yellow.
- 52(53) Joint 3 dark, whitish only in basal third.

- a(b) Joints 1 and 2 dark. The short cross-bars of the fore wings narrowly united cf. *wittmeri* Pr.
- b(a) Joints 1 and 2 yellowish. Cross-bars, though widened at hind margin of wing, not united *pulcher* Oett.
- 53(52) Antennal joint 3 pale, dark only at extreme apex.
- 54(55) Prothorax pale yellow, sometimes with dark central spot. cf. *collaris* Pr. (and 38 ff.)
- 55(54) Prothorax dark.
- 56(57) Segments II and III of abdomen pale yellow or whitish. Antennae very slender. Sensory area on joint 4 short, narrow, not arched *albicinctus* Hal., f. *macr.*
- 57(56) Segment II whitish. Antennae shorter and stouter. Sensory area of 4 larger, somewhat widened towards tip and slightly arched. cf. *cursor* Pr.
- 58 (3) Abdominal segment X orange.
- 59 (60) Segments II and III of abdomen clear white. Antennae very slender ; sensory area on joint 4 not quite reaching apex of joint and not attaining middle. Wings vestigial *albicinctus* Hal., f. *brach.*
- 60(59) Wings fully developed. Sensory area of joint 4 long, occupying more than half of joint. Cross-bars of fore wings long.
- 61(62) Segment II or III of abdomen or both pale *ericae* Bagn.
- 62(61) Abdomen (except segment X) dark. *ericae* f. *muelleri* Pr.
- 63 (2) Tips of middle and hind tibiae whitish.
- 64(65) Two separated cross-bars. Thorax paler than head. Body pigment yellow-orange. *mas-flavus* Pr.
- 65(64) Fore wings either with one very long bar or with two shorter ones which are united at posterior margin. Body usually with crimson pigment.
- 66(67) One long dark bar which medianly often shows a more or less distinct clear spot near fore margin (f. *melaleuca* Uz.). Head somewhat produced in front. *versicolor* Uz.
- 67(66) Two dark cross-bars, more or less broadly united at hind margin.
- 68(69) Head shorter, somewhat produced in front of eyes. Antennals 3 and 4 whitish. Cross-bars broadly united. Wings broader than in *versicolor*. *versicolor* f. *similis* Pr.
- 69(68) Head often longer but not produced in front of eyes.
- 70(71) Larger species. Cross-bars broadly united. Wings length 915-950 μ . Antennal joints 3 and 4 dark at apical margin. Head comparatively long. *titschacki* Pr.
- 71(70) Smaller species. Cross-bars very narrowly united. Wings much shorter.
- 72(73) Joint 3 pale ; length of it : 80, of 4 : 69-71 μ *parvicornis* Bagn.

- 73(72) Antennal joint 3 slightly shaded at apex, much longer than 4, length of 3 : 96-97, of 4 : 71-76 μ *eremicola* Pr.
 74 (1) Body pale yellow, abdomen more or less shaded at apex.
 75(76) Three terminal segments of abdomen dark. Apical half of joint 4 and all the following joints blackish. Cross-bars of wings normal.
 *gloriosus* Bagn.
 76(75) Segment X of abdomen shaded apically. Joints 1-3 light, 4 light at base. Cross-bars very short, partly dissolved into spots.
 *montivagus* spec. nov.

2. Males

- 1(33) Segment IX of the abdomen *with* claspers.
 2(11) Lateral bristle of segment IX *not* stout and sickle-shaped.
 3(10) Dorsal plates (appendices) of tergites IV and V vestigial or wanting.
 4 (9) Antennae shaded. Body dark. Claspers bidentate.
 5 (6) Antennae very slender, length of joint 3 about 115 μ . Sensory area of joints 3 and 4 not reaching middle. Interstitial bristle on tergite IX surpassing claspers (Fig. 10) *fasciatus* L., Bagn.
 6 (5) Antennae less slender, joint 3 at most 80 μ long.
 7 (8) Sensory area of joints 3 and 4 reaching beyond middle. Interstitial bristle long, over 80 μ , surpassing claspers *propinquus* Bagn.
 8 (7) Sensory area on joints 3 and 4 comparatively very short, their lengths on joint 3 : 17, on 4 20-22 μ . Interstitial bristle much shorter (Fig. 9) *linarius* spec. nov.
 9 (4) Antennae wholly pale yellow. Body pale yellow for the greater part. Claspers not bifurcate, simple (Fig. 12) *mas-flavus* Pr.
 10 (3) Dorsal plates (appendices) well developed at least on tergites IV and V. Antennae stouter than in *fasciatus*. Interstitial bristle of segment IX not surpassing claspers (Fig. 11) *intermedius* Bagn.
 11 (2) Lateral bristle of segment IX more or less thickened, almost sickle-shaped.
 12(13) Joint 4 of antennae pale, shaded but at extreme base and at tip, even joint 5 partly pale *priesneri* Kn.
 13(12) Joint 4 dark.
 14(15) Claspers unidentate. Antennal joint 1 vividly yellow, 2 and following joints dark, 3 whitish in basal half. Cross-bars of wings long.
 *insularis* Pr.
 15(14) Claspers bidentate.
 16(26) Bristle 1 of dorsal plate of tergite IX placed *near middle* of plate, far distant from bristle 2.

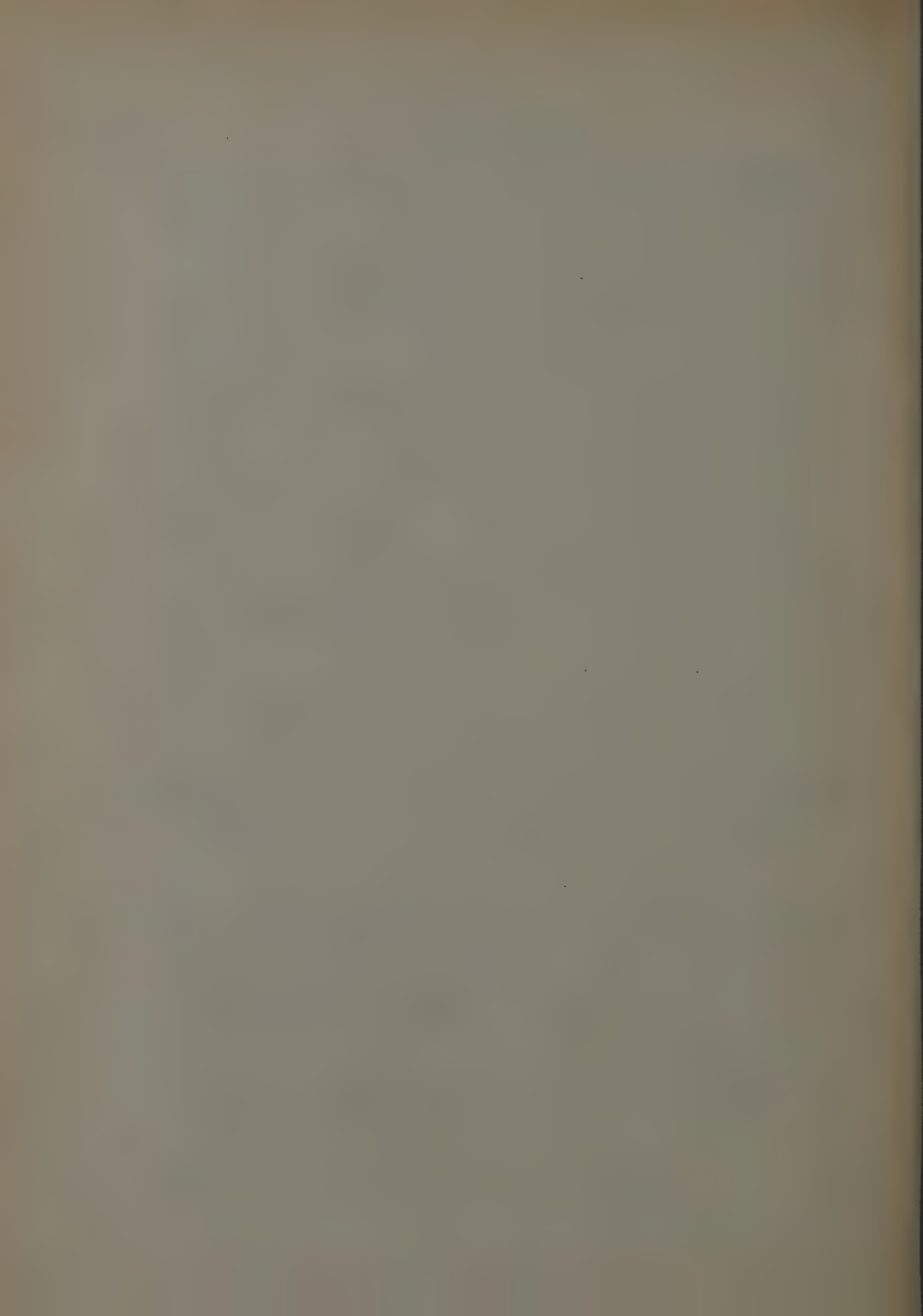
- 17(22) Sensory area of joint 4 not reaching middle. Appendix of segment IV of abdomen at most slightly transverse.
- 18(21) Tergites IV to VI each with a dorsal appendix. Dorsal bristles of plate of segment IX well developed, about 60-80 μ , closer to each other than to b.2. Sickie bristles very stout.
- 19(20) Antennae shorter, joints 4 and 5: 64-72 and 58-65 μ . Appendices on tergite III wanting, those on IV measuring 20-24 μ in width ...
..... *clavicornis* Bagn.
- 20(19) Antennae longer and slenderer, joints 4 and 5: 82-88 and 72-84 μ long. Sometimes a pair of rudimentary appendices on tergite III, those on IV measuring 28-32 μ in width ...
..... *tenuicornis* f. *anthyllidis* Bagn.
- 21(18) Abdomen without dorsal appendices. Bristles on dorsal plate of segment IX short, very fine, closer to b.2 than to each other. Sickie-bristles weak cf. *linarius* spec. nov.
- 22(17) Sensory area of joint 4 reaching or surpassing middle, rarely short, in this case that on 3 long.
- 23(24) Sensory areas on antennals 3 and 4 very long. Cross-bars very long. Appendix on tergite IV strongly transverse, on V lancet-shaped. Dorsal plate of tergite IX nearly reaching base of segment. Sickie-bristle stouter. Antennal joint 5 at least 72 μ long. *ericae* Bagn.
- 24(23) Sensory areas and dark cross-bars shorter. Sickie-bristle weaker.
- 25 26) Appendix of tergite IV moderately transverse, on 5 short, not lanceolate, just bluntly triangular. Bristles on plate of tergite IX: 24-32 μ long. Dorsal plate on tergite IX not or little surpassing middle.
..... *ghabni* Pr
- 26(25) Appendix on tergite V longer. Dorsal plate of IX nearly reaching base, bristles 48-52 μ long. *ghabni* ssp. *insulanus* Pr.
- 27(28) Antennal joint 6 unusually long (31-34 μ long, 18-20 μ broad). Dorsal bristles 1 of plate on tergite IX far apart from each other. Sickie-bristle weak (Fig. 8) *arnebiae* spec. nov.
- 28(27) Joint 6 of antennae normal.
- 29(32) Joint 5 of antennae in most cases at least somewhat longer than 6 to 9 united. Sensory area on joint 4 at most reaching middle. Antennal joint 3 whitish, shaded at tip.
- 30(31) Cross-bars on wings distinctly longer than broad. Joint 1 of antennae distinctly shaded. Prothorax and abdomen dark. Femora at most paler at base (Fig. 6) *collaris* ssp. *meridionalis* nov.
- 31(30) Cross-bars usually as long as wide. Joints 1 to 3 whitish yellow, 3 somewhat shaded apically. Prothorax yellow. Femora for the greater part light *collaris* Pr.

- 32(29) Antennal joint 5 distinctly shorter than joints 6-9 united. Sensory area on joint 4 reaching beyond middle. Antennal joint 3 more strongly shaded. Pronotum with distinct transversal anastomosing lines *deserticola* Pr.
- 33 (1) Abdominal segment IX without claspers.
- 34(41) Tergite IX *without* pair of spines.
- 35(40) Body dark, at most mesothorax and base of abdomen or only the latter whitish.
- 36(39) Base of abdomen and often the mesothorax whitish.
- 37(38) Hemimacropterous. Antennae shorter. Wings with dark cross-bar and dark apex *cursor* Pr.
- 38(37) Nearly apterous. Antennae longer and slenderer ... *albicinctus* Hal.
- 39(36) Abdomen dark. Wings fully developed. Two more or less fused dark cross-bars or one single very long bar *versicolor* Uz. (and formae)
- 40(35) Body pale yellow, pterothorax sometimes with darkenings. Cross-bars of wings *very* short, second bar dissolved into spots (Fig. 14).
..... *montivagus* spec. nov.
- 41(34) Tergite IX of abdomen before apex with a dark spine on either side. Cross-bars of wings narrowly united at hind margin (Fig. 13).
..... *wittmeri* Pr.

LIST OF SPECIES AND SYNONYMS

- albicinctus* Hal. (1836, *Ent. Mag.*, p. 451; Uzel, *Mon. Thys.* 1895, p. 75)
and f. *flavithorax* Pries. (1926, *Thys. Eur.*, p. 102).
- albicinctus* Karny (1914, *Verh. Zool. Bot. Ges. Wien*, p. 51) = *cursor* Pr.
- albicinctus* Karny f. *macroptera* (*Bosnia, Ilidze*, VIII, 1911) = *ericae* Bagn.
- angustus* Melis (1933, *Redia*, XX, p. 173) = ? *intermedius* Bagn.
- anthyllidis* Bagn. (1932, *Ent. Mo. Mag.*, 68, p. 161) = *tenuicornis* v. *anthyllidis* Bagn.
- arnebiae* spec. nov.
- astutus* Pries. (1926, *Thys. Eur.*, p. 109) = *propinquus* Bagn.
- astutus* f. *atricornis* Maltb. (1928, *Ent. Meddel.*, 16, p. 163) = *propinquus* f. *atricornis* Maltb.
- brevicinctus* Bagn. (1934, *Ent. Mo. Mag.*, 70, p. 125) = *collaris* f. *fulvicollis* Bagn.
- bucheti* Bagn. (1934, *Ann. Mag. Nat. Hist.* (10), 14, p. 484).
- citricinctus* Bagn. (1933, *Ann. Mag. Nat. Hist.*, 11, p. 649)
- citricollis* Bagn. (1934, *Ent. Mo. Mag.*, 70, p. 126).
- clavicornis* Bagn. (1934, *Ent. Mo. Mag.*, 70, p. 122).

- collaris* Pries. (March 1919, *Sitzsch. Abad. Wiss. Wien*, 128, p. 119) and f. *fulvicollis* Bagn. (Oct. 1919, *Ann. Mus. Nat. Hist.*, 9, 4, p. 266) and ssp. *meridionalis* nov.
- constrictus* Pries. (1914, *Ent. Zeit. Frankfurt*, 27 = *melaniscus* Hal. (pro Uzel).
- cursor* Pries. (1938, *Bull. Soc. Fouad I^{re} d'Ent.*, p. 111).
- descripta* Pries. (1929, *Bull. Soc. Roy. Ent. d'Egypte*, p. 61).
- eremita* Pries. (1937, *Bull. Soc. Roy. Ent. d'Egypte*, p. 212).
- erica* Bagn. (1920, *Ent. Mo. Mag.*, 6, p. 69) and f. *maclurei* Pries. (1920, *Jahresh. Mus. Wien*, 78, p. 51), *atereum* Hnkk. (1935, *Ann. Ent. Fouad*, 1, p. 88), *albatareata* Keler (1936, *Inst. Nat. Spéiosocet*, 15, p. 87).
- extinctus* Pries. and Quiev. (1955, *Bull. Soc. Géol. France, 5^e ser.*, 3, p. 473) [fossil].
- fasciatus* L., Bagn. (1761, *Fauna Suec.*, p. 266; Bagnall, 1964, *Ent. Mo. Mag.*, 70, p. 120 ff. and f. *annuus* Muls. (1927, *Hedström Käthdrulsk. Aarskr.*, p. 14).
- fasciatus* W. Hesse's (1925, *Insects and related Pests Egypt*, 2, p. 81, fig. 3 ab) = *collaris* ssp. *meridionalis* Pr.
- fasciatus* f. *aptera* Karny (1916, *Mon. Nat. Var. Wien*, 5, 2, p. 44) = *intermedius* Bagn. (wings torn off).
- fasciatus* f. *adusta* Uz. (1895, *Mon. Phys.*, p. 75; Pries., 1926, *Phys. Norv.*, p. 106) = *intermedius* f. *adusta*.
- fasciatus* var. *collaris* Pries. = *collaris* Pr.
- fasciatus* var. *ramulicornis* Pries. (1926, *Phys. Norv.*, p. 107, Annul.) = *fasciatus* L., Bagn.
- fulvicollis* Bagn. (1919, *Ann. Mus. Nat. Hist.*, 9, 4, p. 266) = *collaris* f. *fulvicollis* Bagn.
- glabrum* Pries. (1937, *Bull. Soc. Roy. Ent. d'Egypte*, p. 214) and ssp. *concoloratus* Pr. (t. c., p. 216).
- gloriosus* Bagn. (1914, *Ann. Mus. Nat. Hist.*, 5, 14, p. 375).
- insularis* Pries. (1933, *Scandin. Ent. Zoot.*, 94, p. 188).
- intermedius* Bagn. (1934, *Ent. Mo. Mag.*, 70, p. 126) and f. *adusta* (= *fasciatus* f. *adusta* Uz., Pries. p.p.).
- linarius* spec. nov.
- maculosus* Bagn. (1920, *Ent. Mo. Mag.*, 6, p. 62) = *consociatus* f. *maculatus* Uz.
- maculosus* Bagn. var. *consociatus* Bagn. (1920, t. c.) = *consociatus* f. *simplex* Pr.
- maxillatus* Pries. (1933, *Scandin. Ent. Zoot.*, 94, p. 181).
- melaniscus* Hal. (1851, *Tomus. Ins. Soc. Linn.*, p. 1117) and f. *adusta* Pries. (1926, *Phys. Norv.*, p. 111).
- melaniscus* Uz. (1895, *Mon. Phys.*, p. 71) = *consociatus* f. *melaniscus* Uz.



Oviposition of the Bean Weevil: *Acanthoscelides obsoletus* Say

[Coleoptera : Bruchidae]

(with 8 Tables)

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INTRODUCTION

Reproductive activity and the duration of life are two biological variables which play important roles in the economy of any species. The relationship between them have not only broad biological significance but also, in many cases, considerable economic importance.

As some of the different factors affecting the longevity of the bean weevil has been investigated and analyzed by the writer (1948) it become necessary to investigate some of the conditions which affect the rate of oviposition, in order to discuss the relationship between the two variables.

The effects of temperature, humidity, mating, food and density of population on the total amount of oviposition are outlined in this paper.

METHODS AND MATERIALS

The methods used for rearing the weevils, conditioning of the beans, obtaining unmated weevils, and for controlling temperature and humidity, were the same as described in my previous paper on longevity (this Bulletin, pp. 51-70).

THE EFFECT OF TEMPERATURE AND HUMIDITY

All the weevils used in these experiments were reared on red kidney beans at 24° C. and 70 % R.H. The dates of emerging, starting and stopping of eggs laying and death were recorded. By the recording of these different dates, the ovipositional periods, namely pre-ovipositional, ovipositional and post-ovipositional periods were obtained. Eggs were counted and removed daily. The effect of five different temperatures and six relative humidities on these variables was investigated.

Different temperatures used were : 15, 18, 21, 25, and 30° C.

Different relative humidities used were : 30, 55, 65, 75, 90, and 100 %.

At every combined temperature and humidity the results of 20 specimen tubes, each of which contained one male and one female and three seeds of conditioned red kidney beans were recorded. The effect of both temperature and humidity on every variable (total number of eggs, ovipositional and pre- and post-ovipositional periods) and shown in the following Tables.

TABLE I

*The effect of combined Temperature and Humidity
on the total output of Eggs*

TEMPERATURE IN °C.	RELATIVE HUMIDITY					
	30 %	55 %	65 %	75 %	90 %	100 %
	NUMBER OF EGGS	NUMBER OF EGGS	NUMBER OF EGGS	NUMBER OF EGGS	NUMBER OF EGGS	NUMBER OF EGGS
15	32±7	41±7.8	43±9	40.1±7.6	40.1±8.8	—
18	41±11	46±8.3	47.2±5.2	50.5±7.6	50.7±9.4	—
21	41.4±8.3	50.6±15	65.8±13.2	61±7.2	58±12	43.5±13
25	41.15±5.4	51.1±8.3	59.1±9.7	62.5±12	73.6±8.6	51.2±15
30	42.8±7.8	41.3±5.6	44.8±11	48.7±9.6	49.15±11	—

TOTAL NUMBER OF EGGS

Temperature

Table I shows clearly that both temperature and humidity had a marked effect on the total number of eggs deposited per female. The total number of eggs increased as the temperature was increased from 15 to 25° C. At 30° C. a reduction in the number of eggs was noticed. This was observed at relative humidities ranging from 30 to 100 per cent.

The greatest number of eggs is laid at 25° C. which at high humidities is the optimum temperature of those used.

Menusan (1935) stated that the optimum temperature for oviposition of the bean weevil was 27° C. at 90 % R. H. Weevils kept at those conditions laid an average of 67 eggs. Headlee (1917) stated that the number of eggs laid by the female bean weevils which were kept at 80° F. (nearly 25° C.) and 100 % R. H. was 42, weevils which were kept at the same temperature, but at 62 % R. H. laid an average of 27 eggs. Comparing these

results with those obtained by the writer or with Menusan's results a great difference will be noticed. In both cases, the number of eggs laid by a single female, was about twice as the number obtained by Headlee. Headlee did not count the number of eggs laid by a single female, but counted the progeny of several weevils which were kept together in a glass jar. Under such conditions several other factors affect the rate of oviposition. The water content of the beans used for rearing the weevils has a great effect on the number of progeny per weevil. Unconditioned beans with a low water content cause a very high mortality among the larvae during development. Headlee apparently did not condition the beans which he used as a host for the weevils.

Secondly, the effect of population density on reproduction was also overlooked by Headlee. Later on, it will be shown that the number of eggs laid by a single female decreased as the number of weevils kept together was increased. These two factors as well as the influence of the temperature and humidity at which the weevils were reared may explain the low oviposition figures obtained by Headlee.

If eggs collapsing or drying out within a day after oviposition are considered unfertilized, then at 30° C., females deposited more unfertilized eggs than females at lower temperature. At 21° C. and 25° C. temperature nearly one per cent of the eggs appeared to be unfertilized, while at 30° C. more than five per cent collapsed.

At low temperature there was an intermittent deposition of eggs by the females. At 15° C. females would oviposit for from one to three days, then either oviposit at a greatly reduced rate or not at all for one or two days.

Humidity

Table I shows that except perhaps at low temperature, the number of eggs laid by a single female increases as the relative humidity was increased (up to 90 % R. H.). On the whole the higher relative humidities favoured oviposition. Table I also shows that the effect of the relative humidity was not the same at different temperatures. At low temperature, increasing the relative humidity over 55 per cent caused little or no increase in the number of eggs. At 25° C. the increase in the relative humidity up to 90 per cent caused a remarkable increase in the number of eggs deposited per female. At 30° C. the increase in the relative humidity caused a small but regular increase in the total number of eggs.

The difference in the effect of the relative humidity according to the temperature used on the total output of eggs was similar to its effect on longevity.

TABLE II
*The effect of combined Temperature and Humidity
 on the Ovipositional periods*

TEMPERATURE IN °C.		RELATIVE HUMIDITY														
		30 %			55 %			65 %			75 %			90 %		
		PRE-OVPOSITIONAL	OVPOSITIONAL	POST-OVPOSITIONAL	PERIOD IN DAYS	PRE-OVPOSITIONAL	OVPOSITIONAL	POST-OVPOSITIONAL	PERIOD IN DAYS	PRE-OVPOSITIONAL	OVPOSITIONAL	POST-OVPOSITIONAL	PERIOD IN DAYS	PRE-OVPOSITIONAL	OVPOSITIONAL	POST-OVPOSITIONAL
15	9.6	12.3	15.8	5.1	14.6	15.6	5.7	15.0	15.6	6.1	15.2	14.7	7.6	18.2	11.6	11.6
18	4.1	11.6	13.3	4.1	12.4	12.6	4.8	13.7	11.1	5.4	13.5	10.7	5.8	14.2	10.4	10.4
21	4.3	7.8	4.2	3.0	8.3	6.3	3.1	8.4	6.5	3.2	9.9	6.9	3.6	9.4	7.7	7.7
25	3.2	5.9	4.3	3.6	6.2	4.7	3.1	7.6	3.9	2.5	9.7	2.7	1.9	10.2	2.5	2.5
30	2.6	4.6	3.7	1.7	4.9	3.8	1.6	5.6	4.1	1.9	4.7	3.4	1.8	5.8	2.8	2.8

Each figure is the average for 20 experiments

Each figure is the average for 30 experiments

THE OVIPOSITIONAL PERIODS

Table II showed that both temperature and humidity had a marked effect on these periods. These periods tended to decrease as the temperature at which the adults lived was increased. This effect was observed at all the different humidities used. As for the effect of the relative humidity on these periods, a clear relation between its effect and the pre- and post-ovipositional periods could not be detected owing to the irregularity of that effect, but Table II showed that the ovipositional period tended to increase as the relative humidity was increased. 90 % R. H. which was found to be the optimum humidity for oviposition, is also the humidity at which the ovipositional period is longest.

It is of some interest to examine the relation between the ovipositional period, longevity and the total number of eggs per female. Table III gives the longevity, the ovipositional period and the total output of eggs at different temperatures and 75 % R. H.

TABLE III

*The relation between Longevity, Ovipositional period
and total output of Eggs*

TEMPERATURE IN °C.	NUMBER OF EGGS	OVIPOSITION PERIOD IN DAYS	FEMALE LONGEVITY IN DAYS	RATIO BETWEEN OVIPOSITION PERIOD AND LONGEVITY IN DAYS
25	62.50	9.65	14.80	0.65
21	61.00	9.90	20.00	0.49
18	50.50	13.50	29.50	0.45
30	48.70	4.75	10.00	0.48
15	40.10	15.20	36.00	0.42

The fifth column which gives the ratio between the ovipositional period and the female longevity, shows that the female which laid the highest number of eggs had the highest ratio. Females with the lowest ratio laid the lowest number of eggs. In other words in the less productive group the egg producing was shorter in relation to the whole duration of life than that of the more reproductive group.

In conclusion, it is clear that temperature had the same effect on all the ovipositional periods. They decreased as the temperature at which the adults lived was increased. The total length of all the ovipositional periods

is the female longevity, and it was found before by the writer that the longevity decreased as the temperature was increased.

THE EFFECT OF TEMPERATURE AND HUMIDITY ACTING UPON THE IMMATURE STAGES ON OVIPOSITION

It has been established that temperature and humidity acting upon the mature stage has great effect on the productivity of insects. But very few attempts have been made to distinguish between the effects of temperature and humidity upon the development of the sexual functions or products and upon the immediate expression of these functions or products, i.e. the ultimate sexual effects of temperature and humidity acting upon the immature stages or upon the adults.

Quantitative data on the effect of temperature and humidity acting upon the immature stages on oviposition are few and as far as the writer is aware, no attempt has been made to differentiate between the effect of temperature and humidity upon the development of the sexual capabilities and upon the process of oviposition itself in *A. obsoletus* Say.

Eidman (quoted by Lund 1938) found that when lepidopterous pupae were placed at a low temperature the emerged adults produced fewer eggs. Pospelov (quoted by Imms 1939) showed that in certain lepidoptera the ovaries only mature towards the end of the pupal stage, and when general development was accelerated by high temperature, the adults emerged before they were sexually mature and fecundity was low. Bliss (1927) correlated egg production in several species of leaf-hoppers with the temperature the day previous to oviposition and concluded that temperature was found to condition oviposition more by its indirect action upon egg development than by its direct action on egg deposition. Alpatov (1932) found that when *Drosophila* was reared at 30° C. it produced fewer eggs at 25° C. than did an insect reared at 19° C. Lund (1938) found that rearing *Trichogramma evanescens* at either higher or lower temperature than 25° C. reduced the productivity of the subsequent adults at the standard conditions.

As the number of eggs deposited by the unfed weevils (*Acanthoscelides obsoletus* Say) is determined by the energy which has been accumulated during the immature stages, the effect of temperature and humidity on these stages must play a big part in the determination of the number of eggs deposited. To investigate this effect a number of experiments were carried out.

In these experiments the weevils were reared to maturity at 30, 25, and 21° C. and 55, 65, and 75 % R. H., but were allowed to spend their adult lives at the standard conditions of 25° C. and 70 % R.H.. Thus the influence of temperature and humidity upon the development of the sexual functions and products was tested at a single temperature and humidity. The weevils

were sexed as soon as they emerged, one male and one female were put in a 2 × 1" specimen tube containing three conditioned red kidney beans. The tubes were examined daily, eggs were counted, and recorded. The results are given in Table IV. Each figure in the Table is the average of twenty pairs.

TABLE IV

The effect of combined Temperature and Humidity acting on the Immature Stages on the total output of Eggs

TEMPERATURE IN °C.	RELATIVE HUMIDITY					
	55 % 70 %		65 % 70 %		75 % 70 %	
	PRE-OVIPO- SITIONAL PERIOD IN DAYS	TOTAL NUMBER OF EGGS	PRE-OVIPO- SITIONAL PERIOD IN DAYS	TOTAL NUMBER OF EGGS	PRE-OVIPO- SITIONAL PERIOD IN DAYS	TOTAL NUMBER OF EGGS
20 25	6.8	35.8	4.9	49.9	—	—
25 25	2.2	41.2	2.2	49.7	1.9	55.0
21 25	3.0	57.0	2.6	78.2	3.7	40.7
Above line: conditions at which the weevils were reared						
Below line: conditions at which the adults were kept						

It will be seen from Table IV that the relative humidity in which the weevils were reared to maturity had some effect on the total output of eggs of a single female. The total output of eggs increased as the relative humidity was increased. So, in general, relative humidity has the same general influence upon egg production when it acts upon the developmental period as when it acts upon the adult itself.

As for the effect of temperature acting upon the immature stages, it was found that the total output of eggs increased as the temperature was lowered. The highest number of eggs was deposited by females reared at 21° C. Earlier in this paper it was shown that for adults 25° C. was the optimum temperature for oviposition.

So the effect of temperature acting upon the immature stages differs from its effect when it acts on the adults. This effect was more pronounced

when the influence of the temperature was exerted on the immature stages, in other words, when it acts during the long developmental period than when it influenced directly the function of oviposition during the short adult life.

The increase in the number of eggs deposited by females reared as low temperature may be because the developmental period at low temperature is longer than that at high temperature. So, during the long period of development, the insect may have been able to accumulate more egg-producing substances (fat-body) than during the short period of development. It was also observed during this work that weevils of both sexes which were reared at low temperature were larger and heavier than those which were reared at higher temperature.

Pre-ovipositional Period

Table III shows that there is a pronounced difference in the pre-ovipositional period of weevils developing at different temperatures. Weevils which were reared at 30° C. had a very long pre-ovipositional period, in some cases over 6 days. In looking for an explanation of the influence of high temperature on the delay in the beginning of egg production, it should not be forgotten that in this phenomenon the male might be responsible as well as the female. It is not clear whether the lack of copulation or the absence of ripe sperm early in the life of the weevils may not be in part the cause of the delay in egg-production. The most plausible explanation is perhaps that the development of different organs in the bean weevil is differently affected by the accelerating influence of high temperature. On this hypothesis the females (and perhaps the males) kept at high temperature during larval and pupal life may be supposed to emerge with rudimentary gonads, as in Pospelov (1911) observations.

Another possible explanation is the effect of high temperature on the emergence of the weevils after the last moult. High temperature might have shortened the period spent inside the beans after the last moult. The time which is usually spent inside the beans after the last moult might have been spent outside and thus included in the pre-ovipositional period.

THE EFFECT OF FOOD DURING THE ADULT STAGE ON OVIPOSITION

It became clear after carrying out the previous experiments on longevity (Zaazou 1948) that weevils which were fed on sugar solution or honey lived longer than those without food. It was apparent that weevils receiving no food were dying prematurely, and the dissection of several dead weevils showed that the fat-body was not completely exhausted. Some eggs were seen in the female oviduct after death. This observation indicated that dead weevils (unfed) never laid their full output of eggs.

It has been usually accepted that the adult insect in general can sustain life on a diet of sugar but requires proteins for the development of its genital products. It is of great biological significance to find out how far food affects the rate of oviposition of the bean weevil, especially after it has been established that it does not live only in the warehouses where there is no available supply of liquid food, but also outdoors where suitable food is available such as nectar and dew.

Before describing the experiments which were carried out, some of the outstanding work which has been done on the effect of nutrition on the rate of oviposition in insects may be usefully mentioned here.

Glaser (1923) showed that the adult house-fly (*Musca domestica*) only lived a very short time if kept without food, or if fed exclusively on proteins, that the longevity was increased, but still no eggs were laid when they were fed exclusively on saccharose, and that maximum longevity and oviposition were only obtained when it was given a diet including both sugars and proteins.

Kastner (1929) showed that the onion-fly (*Hylemia antiqua*) maintained life for a much longer time on sugar solution than on water, but maximum longevity and oviposition were only produced when proteins in the form of casein or nectar were included in the diet.

Philips (1927) recorded that the adult honey-bees lived an average of from 6.9 to 8.9 days on various kinds of sugar as compared with from 1.7 to 4.3 days on water only.

It is known that many female mosquitoes require a meal of blood before the eggs can be ripened, although they can sustain life on a purely sugar diet. A good example of the necessity of blood for oviposition in mosquitoes is found in *Aedes calopus* (the yellow fever mosquito). The female of this species can, as described by Howard, Dyer and Knab (1912), be kept on honey, but no eggs will ripen until blood is obtained, and repeated meals of blood are necessary for the development of all eggs.

Richards (1927) has summarized the tendency for the females of a species to take nitrogenous food to a greater extent than the males which has been noticed in many families of insects. These habits include such phenomena as the eating of the spermatophore by the females after mating, the eating of the males by the females after mating, and the presentation by the male of a drop of fluid which is drunk by the female during mating. Directed towards the same end would seem to be the tendency for the females of predacious insects to be more voracious than the males.

Guyenot (1917) in his experiments on rearing *Drosophila* on sterile media found that the adult flies lived 10, 15, 20 or more days on a medium containing peptones and sugars, as compared with 3-4 days on a medium

containing peptones and no sugar. The fecundity of the sugar fed flies was also higher than those deprived of sugars.

The experiments of Larson and Fisher (1925) on *Bruchus quadrimaculatus* do however, appear to furnish an example of an increase in the fecundity induced by sugar feeding, the sugar-fed females showed an increase in the mean fecundity of about 10 per cent and an increase in longevity of about 17 per cent as compared with the water-fed ones.

Swingle (1928) describes another condition in *Laspeyresia molesta* Busch (the Oriental fruit moth). He found that the average number of eggs laid was not increased by feeding the moths on sugar instead of water, but the moths died, having laid hardly any eggs unless water was available.

For more information on that subject the reader is referred to the works of Uvarov (1928) and Norris (1934). It is clear however that the great body of evidence does suggest that in insect in general while a sugar diet is sufficient and necessary for maximum longevity a nitrogenous food is necessary for egg production.

The experiments which will be described later, were conducted to determine whether or not the presence of certain foods will increase the number of eggs laid by a single female, and also to find out how they will affect the ovipositional periods.

Eighty $2 \times 1''$ specimen tubes, each containing newly emerged weevils which were taken from a stock culture maintained on red kidney beans at 24°C . and 70 % R. H. were used. They were divided into four sets 20 tubes each. In each of the first 20 tubes a drop of water was put; the second twenty each received a drop of honey, to the third twenty, a drop of saturated water-sugar solution was added. The remaining 20 tubes which contained only red kidney beans were used as a control. All these tubes were kept at 25°C . and 70 % R.H. Water, sugar solution, and honey were replenished as needed. Eggs were counted daily and the female weevils were dissected after death to see the condition of the fat-body. The results are shown in Table V.

It can be seen from Table V that the average number of eggs laid by a female receiving water was slightly higher than that of the non-drinkers. The ovipositional period did not seem to be affected at all by water drinking, both the drinkers and the non-drinkers having nearly the same ovipositional period.

Taking now the condition of the fat-body into consideration, it was very interesting to note that all the weevils which were deprived of water died with a large quantity of unused fat-body, whereas 10 per cent of the weevils given water had the fat-body completely exhausted at death.

All these differences between the drinkers and the non-drinkers are very

small if compared with those found in allied species *Bruchus quadrimaculatus*. Larson and Fisher (1925) found that the fecundity of *B. quadrimaculatus* was reduced by over 30 per cent when deprived of water. They did not mention the condition of the fat-body as the females were not dissected after death.

They also found that the longevity of the weevils receiving water was increased by nearly 17 per cent.

TABLE V

The effect of Water and Food on Oviposition

WEEVILS GIVEN WATER			WEEVILS FED ON SUGAR SOLUTION		
AVERAGE NUMBER OF EGGS	AVERAGE OVIPOSITIONAL PERIOD IN DAYS	CONDITION OF FAT BODY	AVERAGE NUMBER OF EGGS	AVERAGE OVIPOSITIONAL PERIOD IN DAYS	CONDITION OF FAT BODY
63	8.5	90 % not exhausted	106	31.7	Completely exhausted
WEEVILS FED ON HONEY			WEEVILS USED AS A CONTROL		
AVERAGE NUMBER OF EGGS	AVERAGE OVIPOSITIONAL PERIOD IN DAYS	CONDITION OF FAT BODY	AVERAGE NUMBER OF EGGS	AVERAGE OVIPOSITIONAL PERIOD IN DAYS	CONDITION OF FAT BODY
111.5	31.5	Completely exhausted	56.4	8.2	100 % not exhausted

Norris (1934) stated that the fecundity of both *Ephestia cautella* and *E. elutella* was approximately halved if they were deprived of drinking water, while the effect of water drinking on the both the fecundity and the longevity of *Ephestia kuhniella* was very slight. This indicated that the effect of water drinking on allied species might differ, one species might be greatly affected by drinking water, while the effect on the fecundity and the longevity of another species might be very slight.

This was found in two species of Bruchidae: *Bruchus quadrimaculatus* was greatly affected by drinking water according to Larson and Fisher, while the effect on *Acanthoscelides obsoletus* was very slight.

As for the effect of food (honey and sugar solution) Table V shows increase in the average number of eggs laid by weevils receiving food. Females fed on sugar-solution laid an average of 106.1 eggs, while those fed

on honey laid an average of 111.5 eggs. These figures showed that the fecundity of weevils fed on sugar solution was increased by nearly 88.4 per cent, while that of those fed on honey was increased by nearly 97 per cent as compared with those receiving no food.

It was very interesting to note that all the weevils which were supplied with food used all their fat-body, none of them died with any trace of the fat-body in the abdomen.

The ovipositional period for both honey and sugar-fed weevils was also increased. In both cases it was over 31 days. The weevils which received no food had an ovipositional period of 8.2 days.

All these results indicate that sugar solution or honey caused a great increase in the fecundity of the bean weevil. These results seemed unreasonable as it has been shown in the previous review that the protein is the fundamental substance limiting egg production, and the amount of eggs laid by an insect depends entirely on the amount of protein suitable for that purpose in the fat-body.

How this can be explained ?

A reasonable answer will be found if we correlate the longevities of weevils fed on honey or sugar solution or given water with their output of eggs. Table VI collects together the longevities and the egg production of different weevils.

TABLE VI
*Longevity and Egg-production of Weevils
receiving food and water*

FEEDING CONDITIONS	LONGEVITY IN DAYS	NUMBER OF EGGS	OVIPOSITION PERIOD IN DAYS	CONDITION OF FAT BODY
Weevils fed on sugar	59.8	106.1	31.7	100 % exhausted
Weevils fed on honey	62.1	111.5	31.5	100 % exhausted
Weevils given water	16.3	63.0	8.5	10 % exhausted
Weevils given nothing	14.5	56.4	8.3	none exhausted

A very striking correlation between longevity and fecundity can be seen in Table VI. Weevils fed on sugar or honey lived an average of nearly 60 days and laid the highest number of eggs. They also continued to lay eggs for more than 31 days. Not a single weevil in all my work with the bean weevil in which the longevity of more than 1000 weevils has been recorded lived without food for 31 days. The condition of the fat-body was found to be correlated also with the longevity. Weevils which had the highest longevity exhausted all their fat-body, while in the control none consumed

all the fat-body before death. So sugar-solution and honey prolonged the longevity of the adult weevil, gave them enough time before death to utilize all their fat-body, so they were able to lay their full output of eggs, while water did not prolong life sufficiently to allow the weevils to use all their fat-body before death. They therefore did not lay their full output of eggs, but a small number, not far from the number laid by weevils receiving nothing. This is clear from the amount of fat-body left unused in the abdomen of the weevils receiving water and those used as a control. This proves that weevils receiving no food died prematurely without having the chance to lay all their eggs. If they were fed, they lived long enough to use all their fat-body and to lay their full output of eggs.

The experiments of Larson and Fisher (1925) on *B. quadrimaculatus* which appear to furnish an example of an increase in fecundity induced by sugar feeding can also be explained on the same basis. Unfortunately they did not mention the condition of the fat-body after death.

This cannot be taken as a definite solution for this particular case unless more experiments are carried out and the condition of the fat-body further investigated.

THE EFFECT OF FOOD DURING DEVELOPMENT ON THE RATE OF OVIPOSITION

It has been stated before that the adult bean weevil living in warehouses does not feed, but depends entirely during its adult stage on the energy which has been accumulated during development. Menusan (1935) came to the conclusion after some preliminary experiments that females reared on different varieties of beans might not oviposit at the same rate or give the same number of eggs. Herford (1935) after stating that the bean weevil attacks a large variety of seeds found that there was a large difference in the size of the female weevils reared on different kinds of seeds.

To obtain accurate data about the number of eggs laid by females reared on different varieties of seeds a series of experiments were conducted as follows.

Seven varieties of seeds were selected and were kept at 25°C. and 70 % R.H. for nearly two months till they reached equilibrium with the environment. In seven petri dishes 10 × 1.5 cm. were placed a single layer of about 150 seeds, one dish of each variety. Over this layer of seeds were sprinkled 20 newly emerged weevils which had been reared on red kidney beans.

All the dishes were kept at 25°C. and 70 % R.H. till the new progeny

emerged. Eggs laid by weevils emerging from each culture when kept at 25°C. and 70 % R.H. were counted. The results appear in Table VII.

TABLE VII

The effect of Food during development on Oviposition

KIND OF FOOD	NUMBER OF EGGS AND ST. DEV.	KIND OF FOOD	NUMBER OF EGGS AND ST. DEV.
Pea bean	66.3±13.5	Garden pea	35.4±8.3
Red kidney bean	62.8±12.8	Lima bean	27.0±9.2
White kidney bean	61.7±14.0	Haricot bean	20.0±7.6
Black V. bean	60.9±10.7	—	—

Table VII shows that females reared on different kinds of seeds did not oviposit the same number of eggs. The seven varieties of seeds used can be divided into two distinct groups according to the number of eggs laid by females reared on them. The first group which produced females laying a very high number of eggs includes pea bean, white kidney beans, red kidney beans, and black valentine bean. The second group contains lima bean, haricot bean and garden pea.

Further work, especially the chemical analysis of the different seeds, is needed to explain this difference in egg laying. This is being carried out and I hope in the near future an explanation can be found.

THE EFFECT OF POPULATION DENSITY UPON THE RATE OF REPRODUCTION IN THE BEAN WEEVIL

As a result of the previous investigation (Zaazou 1948) involving the analysis of the effect of population density on the longevity of the bean weevil, it became apparent that the population density constituted an environmental factor which had been apparently neglected, doubtless on account of its obscurity, but whose effect were nevertheless of greater significance than generally realized. It seemed desirable, therefore, to investigate its effect on reproduction.

Without undertaking any systematic review of the literature on this subject, some of the investigations may be mentioned. Apart from the very old works of Samper (1874) and Farr (1861), the first observation regarding the effect of crowding upon reproductive rate appears to have been made by Balbiani (1860) who reported that « Paramicium » must be placed in not less than 2.3 cc. of medium to bring about the maximum productivity.

Allee (1931) gives a good account of the effect of population density on several biological phenomena.

The first convincing quantitative evidence of a true density effect was produced by Pearl and Parker (1922). They made a valuable contribution to the problem by their analysis of the effect of population density upon the rate of reproduction in *Drosophila*. This variable was measured by the average number of adult flies produced per mated female per day over a specified period of time, being in reality a measure of what is now generally termed the effective reproductive rate. They found that the number of adult flies produced per female fell continuously as the number of pairs per half-pint bottle was increased from 1 to 50, other conditions being standardized.

Pearl (1932) did more work with *Drosophila*, investigating the density factor, this time dealing with the rate of egg production, not with the effective reproductive rate as variable. He concluded that as the density of population within a limited and closed universe increased the rate of egg production per female decreased.

MacLagen (1932) after analyzing Chapman's (1928) figures of the population density of *Tribolium confusum* and after carrying out more experiments with *Calandra granaria* concluded that the rate of reproduction decreased as the density of population was increased.

To study the operation of the density effect in the bean weevil (*Acanthoscelides obsoletus* Say) a number of experimental environments was arranged so that the initial population of weevils per gram of beans was in geometric series which were set up as follows : 0.07, 0.14, 0.28, 0.56, 1.12, 2.24, 4.48, and 8.96 of gram of beans.

This was obtained by weighing 29 grams of pea beans which has been kept at 70 % R.H. and 25° C. for more than nine weeks. Eight lots of beans each of which weighted 29 grams were obtained, each lot was put in a 10 × 1.5 cm. petri dish. A special care was taken to get the same number of beans, giving the same weights (29 grams). It was found that 160 seeds of pea bean of nearly the same size, gave almost the same weight (29 grams). The eight petri dishes containing 160 pea beans received the following number of weevils respectively : 2, 4, 8, 16, 32, 64, 128, and 256. In all the experiments half the weevils were males and the other half females. The stock culture from which the weevils utilized in the actual experiments were obtained, had been kept for nearly a year on red kidney beans at 24° C. and 70 % R.H.

All the weevils were about 16 hours old, taken at random from the stock culture. As the pre-ovipositional period of the bean weevil is over 2 days at 25° C. (Zaazou 1948), none of the females used in these experiments had started egg laying.

After the weevils had been scattered over the beans, the petri dishes were covered with muslin secured with rubber bands. They were kept throughout the experiments at 25°C. and 70 % R.H.

Since in the act of oviposition, the female weevil moves about amongst the beans, laying eggs on and round them, it was impractical to count the number of eggs deposited by the female. It was therefore decided to count the number of the adult weevils emerging from the beans.

When the first progeny weevil emerged, the old weevils were removed (all died), the progeny being counted and removed as soon as they emerged. No account was kept of the larvae or the pupae as nett reproductive capacity was studied.

Table VIII shows the results of these experiments.

TABLE VIII

The effect of Population density on the Reproductive capacity

Initial number of Weevils	2	4	8	16	32	64	128	256
Weevils per gram of beans . . .	0.07	0.14	0.28	0.56	1.12	2.24	4.48	8.96
Number of beans per female . . .	160	80	40	20	10	5	2.5	1.25
Number of new progeny	45	115	208	217	159	84	35	57
Number of progeny per female . .	45	57.5	52	27.1	9.9	26	0.54	0.44
Number of progeny per female day*	4.5	5.75	5.2	2.71	0.99	0.26	0.054	0.044

*Considering that the ovipositional period was 10 days in such conditions

From Table VIII it can be seen that the two variables, population density and progeny per weevil, exhibited an inverse relationship. The rate of reproduction per female increased till a certain density, which may be called the optimum, after which any increase in the population density caused a decrease in the rate of reproduction. The optimum density was reached when four weevils were kept together (2 pairs).

The total output per female when two pairs were kept together was 57.5 weevils, this output was 45 and 52 weevils when one or four pairs were kept together.

Considering now the relation between the progeny per weevil and the number of beans available, it is evident from Table VIII that the relation was not a direct one. First, the progeny per female increased as the number of beans available decreased till the optimum was reached, then the progeny per female decreased as the number of beans at her disposal decreased. The optimum was reached as the number of beans per female was 80 beans, any increase or decrease in the number of beans per female over or under 80 beans caused a decrease in the number of progeny.

How can these results be explained? What was the cause of the reduction in the progeny per weevil as the density increased?

The first explanation, since we were dealing with imagos only, is that larvae and pupae were eliminated owing to over crowding in those stages.

In the culture with 32 females, there were laid on this view something like 32 times as many eggs as in the culture containing one female, these eggs developed 32 times as many larvae, but there was not enough room or food for all of them, so that many of them were eliminated and the survivors which got through to the imago stage indicated a very low apparent reproductive rate. This explanation cannot possibly account for the facts. To demonstrate this we have only to examine with some care the absolute figures given in Table VIII.

The highest number of progeny obtained was 217 weevils. This number indicated that in all the cultures as they were made of the same number as well as of the same weight of beans, there was enough food and room for at least 217 weevils, but the number of weevils which came through in culture receiving 32 weevils was 159, less than the food available would have supported. Therefore the decrease in the number of progeny cannot be explained on the supposition of larval crowding and elimination. Possibly this factor comes into play in the higher densities, though there is no evidence as yet that such is the fact.

Secondly there was the possibility of the production of a larger number of non-fertile eggs in the higher densities. Unfortunately this possibility was not investigated, but MacLagan (1932) working with *Tribolium confusum* stated that though a higher number of non-fertile eggs was produced in higher densities, the number was very small and could not be the only reason for the large decrease in the number of progeny.

The frequency and the chances of interruption of copulation in the various densities must be also considered. This is undoubtedly an important factor, since it has been observed on several occasions that the greater the intensity of crowding the greater the degree of activation of the weevils, resulting from numerous contacts. A certain amount of contact provides a stimulus for, if not an essential preliminary, to the act of copulation. At low densities there might be a decreased opportunity for cumulation, so that when it did occur it was too late in the life of the weevil to result in the normal productivity. This might be the explanation of the existence of an optimum density for reproductive rate.

Pear (1932) after a very intensive study of the behaviour of *Drosophila* came to the conclusion that crowding produced the observed effect on the rate of reproduction primarily though not solely, as a result of collision or interference of the flies with one another.

So with some reservation, we might accept Pearl's explanation of the phenomenon as being the result of adverse effects upon the reproductive system of what must be termed in the state of our knowledge « psychological influences ». To say that such an effect actually takes place would appear to be correct, but it is not the whole story. Moreover, the so-called psychological effect almost certainly results from the repeated stimulation of excessively numerous physical contacts.

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DU

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